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PHLOX VERMEJOENSIS (POLEMONIACEAE), A NEW SPECIES FROM NORTHERN NEW MEXICO, U.S.A.

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ABSTRACT

Phlox vermejoensis B. Legler is described as a new species from alpine scree slopes in the Sangre de Cristo Mountains of Taos County, New Mexico. This highly distinctive and previously uncollected species is readily distinguished from other members of the genus by its rhizomatous habit, short, tufted stems, broad leaves, corolla tube equal to the calyx, and short styles. Its discovery demonstrates the importance of continued floristic work in North America.

RESUMEN

Phlox vermejoensis B. Legler se describe como una nueva especie de las laderas alpinas de las montañas Sangre de Cristo del Condado de Taos, Nuevo México. Esta especie altamente diferente y no colectada previamente se distingue fácilmente de otros miembros del género por su hábito rizomatoso, tallos cortos formando matas, hojas anchas, tubo de la corola igualando el cáliz, y estilos cortos. Su descubrimiento demuestra la importancia la continuidad del trabajo florístico en Norte América.

The genus *Phlox* L. contains 65 to 70 species, all but two of which are restricted to North America (Wilken & Porter 2005). Although the circumscription of *Phlox*, excluding *Microsteris* Greene, is not in question (Porter & Johnson 2000; Ferguson & Jansen 2002), the genus has been considered taxonomically difficult (Wherry 1955) and relationships among many of the taxa remain poorly resolved due to hybridization, introgression, and polyploidy (Ferguson et al. 1999; Ferguson & Jansen 2002; Ferguson et al. 2010). In addition, many species are narrow endemics. Some of these (e.g., *P. caryophylla* Wherry, and *P. cluteana* A. Nels.) are restricted to one or a few mountain ranges in the southwestern United States. *Phlox vermejoensis*, described here as new, is another such narrow endemic.

Phlox vermejoensis was first discovered by the author in July, 2008 during a floristic inventory of Vermejo Park Ranch (VPR) in the Sangre de Cristo Mountains of north-central New Mexico (Legler 2010). Two populations separated by about 0.5 miles were found that year. Attempts to identify these plants to any previously described species of *Phlox* were not successful, and it quickly became apparent that they represented a new, undescribed species. To the author's knowledge no prior collections of this highly distinctive taxon exist in herbaria, which is not surprising given that the land on which these populations lie has been privately owned since the mid 1800s.

Discoveries such as this contradict the common misconception that the flora of North America has been fully explored and cataloged. To the contrary, much work remains to be done. Hartman and Nelson (1998) reported that the rate of publication of novelties in North America north of Mexico has remained relatively constant since 1955, at an average of 60 per year, while Ertter (2000) estimated that as many as 1,800 more novelties may await discovery in this same area, representing a further increase in the total flora by nearly 5%. These estimates underscore the need for continued floristic inventories, even in seemingly well explored areas such as the United States.

Phlox vermejoensis B. Legler, sp. nov. (**Figs. 1, 2, 3**). Type: U.S.A. New Mexico. Taos Co.: Vermejo Park Ranch, Sangre de Cristo Mountains, NW side of unnamed peak 12673, 2.3 air mi NNE of Big Costilla Peak and 3.25 air mi SSW of State Line Peak, scree slope of metamorphic rock, with *Geum rossii*, *Senecio taraxacoides*, *S.* cf. *soldanella*, *Claytonia megarhiza*, *Androsace septentrio-*

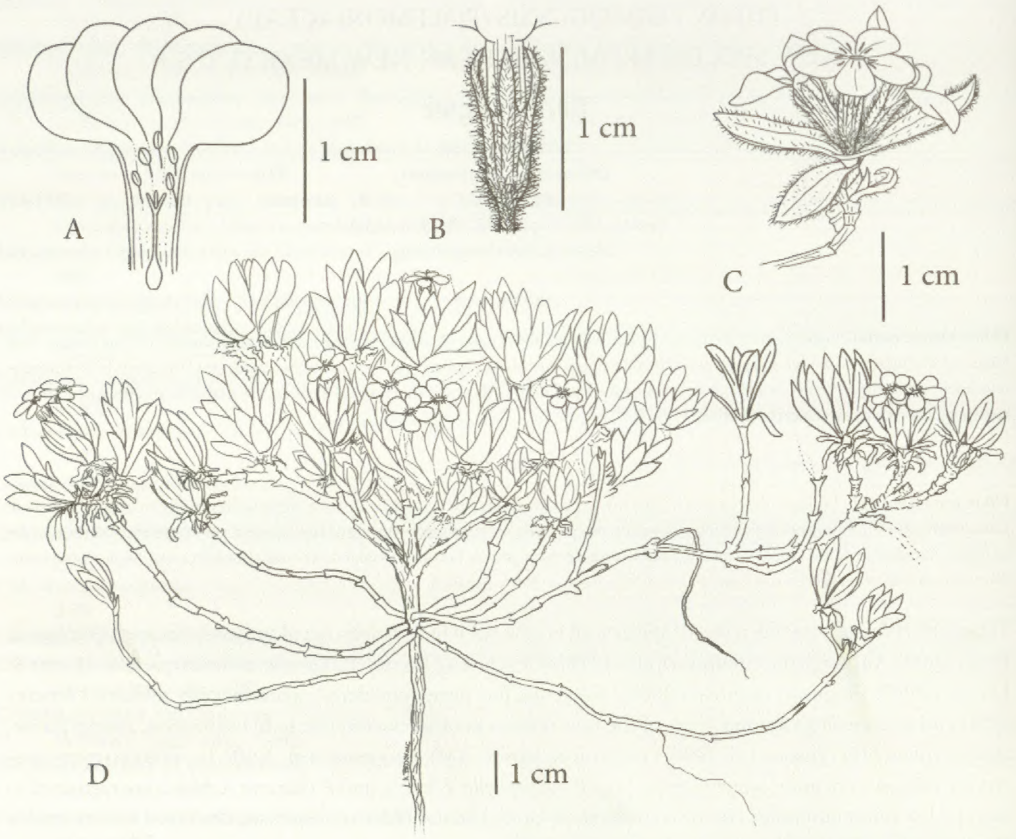

FIG. 1. Illustration of *Phlox vermejoensis*. A) Corolla, split open showing position of anthers and style. B) Calyx tube. C) Above-ground stem with inflorescence. D) Habit and rhizomes.

nalis, *Poa glauca* ssp. *rupicola*, and *Festuca* sp., 36.95209° N, 105.31537° W, elev. 12,610 ft, aspect NW, slope 30–40°, 21 Jul 2009, *B. Legler 11521* (HOLOTYPE: RM; ISOTYPES: ARIZ, COLO, MO, UNM, WTU).

Herba perennis e caudice ramoso, demum rhizomatosa; caules caespites foliosos breves 1–4 cm altos facientes; folia elliptica, oblonga, vel oblanceolata, 6–25 mm longa, 3–8 mm lata, 2.5–5plo longiora quam latiora, glanduloso-pubescentia; inflorescentia 1–4(–6)-flora, glanduloso-pubescens; pedicelli 1–4 mm longi; sepala 8–11 mm longa, membranis calycis intercostalibus planis; corolla alba, saepe purpureo notata ad bases loborum, tubo (7–)8–11 mm longo; styli 3.5–5.5(–6) mm longi, sub antheris positi; capsulae 4.5–6.5 mm longae.

Perennial herb from a much-branched caudex, the caudex and taproot often not apparent, becoming replaced by numerous, branched and tangled rhizomes, these to 15 cm long by 1–3 mm diameter, slender and herbaceous to slightly woody, with internodes 0.5–2 cm long; above-ground stems in clumps or widely scattered at upturned tips of rhizomes, forming short, leafy tufts 1–4 cm tall (including the inflorescence), glabrous or sometimes glandular-pubescent, bases clothed in curled, dead, gray leaves, internodes mostly less than 5 mm long, obscured by sheathing leaf bases; leaves opposite and sessile, spreading to ascending, not appressed, blades elliptic, oblong, or oblanceolate, 6–25 mm long, 3–8 mm wide, mostly 2.5–5 times as long as wide, green, soft and slightly fleshy, abaxial surface glabrous to sparsely pubescent with multicellular, gland-tipped hairs, adaxial surface sparsely to moderately pubescent with multicellular, gland-tipped hairs, margins likewise glandular-pubescent, not noticeably ciliate at base, slightly thickened and papillose near tip but not cartilaginous, the tip acute to obtuse, occasionally apiculate but not pungent, midvein obscure; inflorescence a

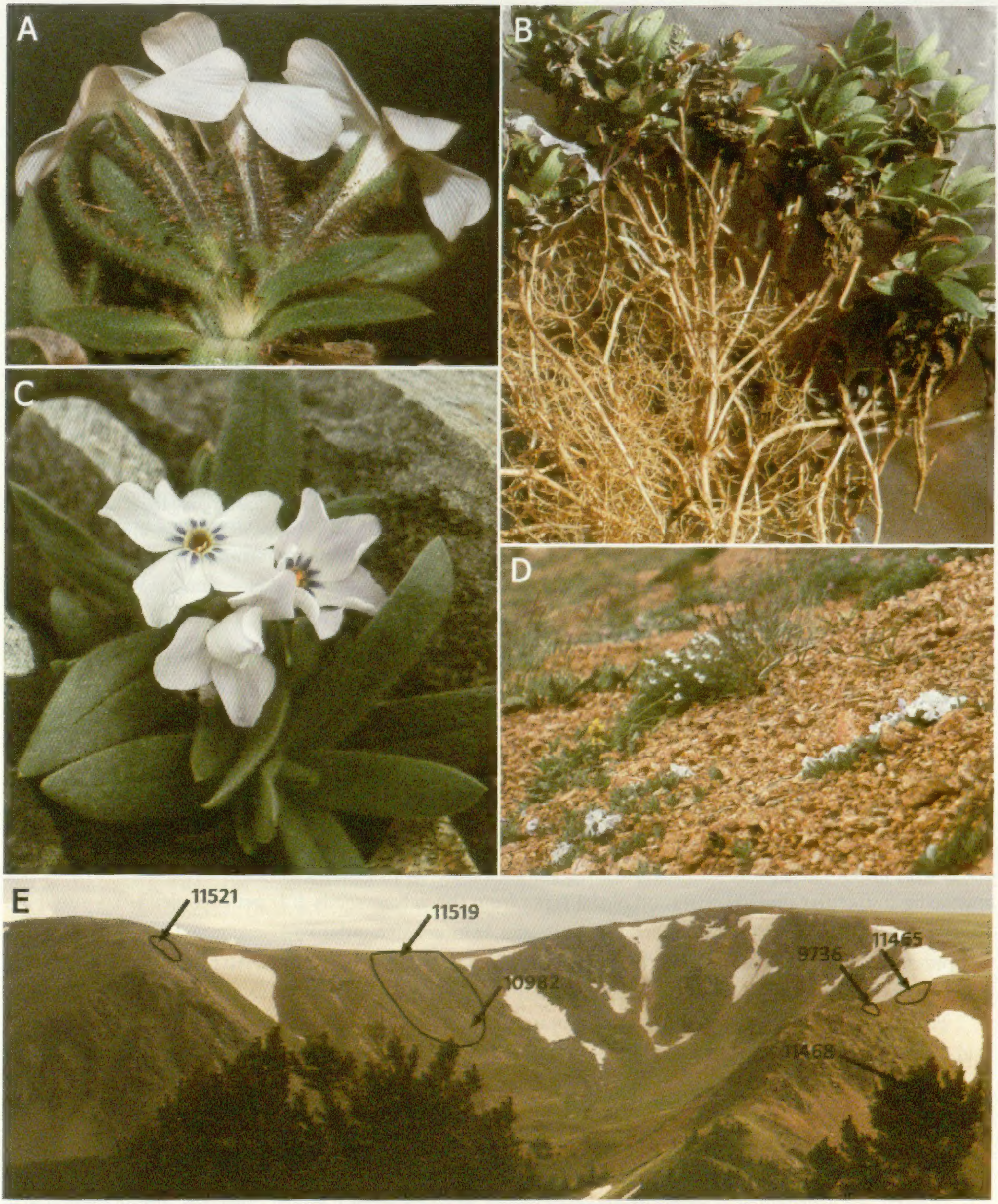

Fig. 2. ***Phlox vermejoensis*. A) Inflorescence. B) Rhizomes. C) Flowers and leaves from the type locality. D) Habit in scree, with plants visible in lower half of photo. E) Habitat, encompassing all known populations, with the locations of individual collections indicated by arrows and collection numbers, and the approximate extent of each population outlined in black. Photos by the author.**

terminal, reduced, leafy cyme with 1–4(–6) flowers; pedicels 1–4 mm, densely pubescent with multicellular, gland-tipped hairs to 0.3 mm long, the glands yellow; sepals 5, narrowly lanceolate to almost linear, 8–11 mm long, 0.4–0.7 mm wide, fused for 4–5 mm at base, outer surface densely glandular pubescent like the pedicels,

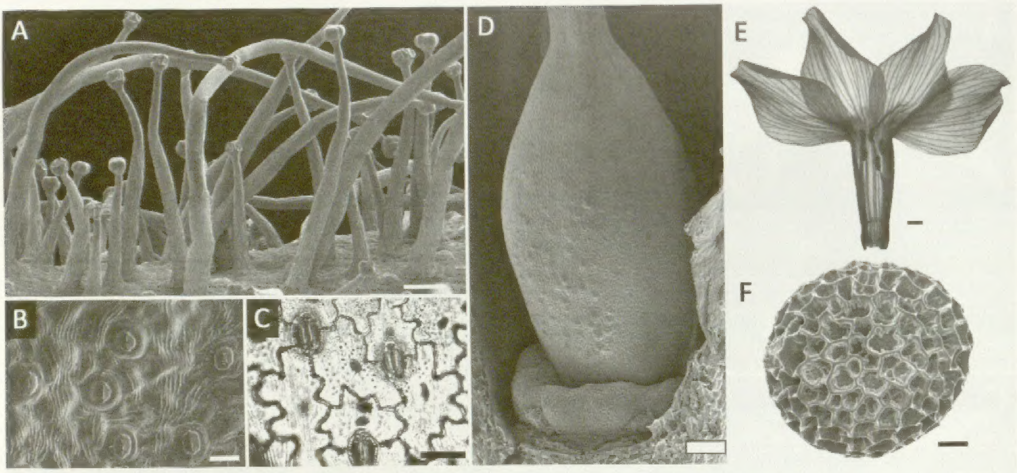

FIG. 3. Scanning electron and light microscope images of *Phlox vermejoensis*. A) SEM micrograph of leaf surface showing gland-tipped hairs; scale = 100 µm. B) SEM micrograph and C) light micrograph of the epidermis of the leaf, illustrating stomata and cell shape; scale = 25 µm. D) SEM micrograph of the ovary and nectary gland; scale = 200 µm. E) Light micrograph of dissected corolla (4 of the 5 lobes present) showing trichomes near the base of the tube; scale = 1 mm. F) SEM micrograph of pollen; scale = 5 µm.

intercostal membrane flat; corolla salverform, regular, white or rarely tinged with pink, often with purple "pinwheel" markings at throat, tube (7–)8–11 mm long, equal in length to the calyx, glabrous except for a ring of eglandular trichomes within near the base, lobes 5, spreading, obovate, 6–9 mm long, 4.5–7.5 mm wide, entire, not notched at tip; filaments 0.8–1.5(–2) mm long, unequally attached on upper half of corolla tube; anthers 5, 0.8–1.8 mm long (mostly either 0.9 mm or 1.4 mm, and of uniform size within each flower), yellow, positioned above the style and stigmas, some slightly exserted from tube; ovary superior, glabrous, with 3 carpels and 3 locules, each locule containing a single ovule; style 3.5–5.5(–6) mm long including the stigmas, stigmas 3, 1.1–1.6(–2) mm long; capsule 4.5–6.5 mm long, 2–3 mm wide, elliptic, tan, glabrous, hardened, with 3 valves, appearing unilocular due to separation of the septa from the valves; seeds 1(2) per capsule, 3–3.6 mm long, 1–1.8 mm wide, elliptic, slightly flattened, light brown, minutely irregular-rugose, cupped on one side by the compressed, boat-shaped remnant of the septa. Chromosome number not known. All measurements are from dried herbarium specimens and dissected, separately pressed flowers.

Pollen morphology.—pollen grains pantoporate, (18–)24–48(–53) µm diameter; pores (12–)18–28, spheroidal, 0.9–3 µm diameter, with considerable variation in size, shape, and exine form; exine 2–4.9 µm, reticulate, heterobrochate; luminae 0.8–9.7(–12.3) µm, polygonal, provided with a micromesh formed by thin bridges hanging between the muri; apertural luminae (brochae) usually smaller than average, 1.8–6.8 µm; muri 0.2–1.4 µm wide, curved to sinuate, simpli- or duplibaculate; bacula 2–2.6 µm long, 0.35–1.2 µm diameter, very densely spaced; nexine 0.5–1.1 µm, slightly thicker, 0.8–1.5 µm, at the pore margins.

Habitat and distribution.—*Phlox vermejoensis* grows on north-facing, stable, vegetated, alpine scree slopes of decomposing granite or metamorphic rock (Fig. 2, D & E). Scree texture varies from pea-gravel to a mix of gravel and angular blocks up to 20 cm diameter, with fine-textured soil immediately below the surface. At one site the granite is distinctly reddish-colored. Most plants are found just below ridge crests where wind-blown snow likely accumulates and increases soil moisture availability relative to adjacent, more exposed slopes. However, no plants were observed around cornices or late-lying snowfields. Slopes vary from 20% to 45%. Vegetation cover ranges from 15% to 60%. Common associated species include *Androsace septentrionalis* L., *Carex rupestris* All., *Claytonia megarhiza* (A. Gray) Parry ex S. Wats., *Eremogone fendleri* (A. Gray) Ikonn., *Geum rossii* (R. Br.) Ser. var. *turbinatum* (Rydb.) C. L. Hitchc., *Minuartia obtusiloba* (Rydb.) House, *Poa glauca* Vahl. var.

rupicola (Nash ex Rydb.) B. Boivin, *Potentilla concinna* Richardson var. *concinna*, *Saxifraga bronchialis* L. var. *austromontana* (Wiegand) Piper ex G.N. Jones, *Senecio taraxacoides* (A. Gray) Greene, and *Trifolium attenuatum* Greene.

Phlox vermejoensis is currently known from two metapopulations about 0.5 miles apart along the crest of the Sangre de Cristo Mountains, about 3 miles south of Colorado and wholly within the confines of Vermejo Park Ranch. The populations occur between 12,200 and 12,600 feet (3,720–3,840 meters) elevation around the perimeter of a northeast-facing glacial cirque. No additional populations were found during intensive surveys by the author in 2008 and 2009 that covered nearly all suitable habitat from the Colorado state line south to the vicinity of Big Costilla Peak, beyond which lies the Costilla Creek Valley and a disruption in alpine habitat. An examination of aerial photographs suggests suitable habitat occurs a few miles to the north in the Colorado portion of the Sangre de Cristo Mountains, particularly in the vicinity of Vermejo and Purgatoire peaks. These peaks lie on large, private ranches with limited access. Additional surveys should be conducted there.

Phenology.—Flowering specimens were collected from July 13–21. The condition of these flowers suggests the bloom period extends from early July through the end of July. Mature capsules with seeds were collected on August 20, and immature capsules are present on a collection made July 18.

Etymology.—The specific epithet *vermejoensis* refers to Vermejo Park Ranch, the boundaries of which encompass the entire known distribution of this new species. The word vermejo, or bermejo, is of Spanish origin, similar in meaning to vermilion, and describes the brick-red color of the Vermejo River when swollen with late summer rains. A suitable common name is Vermejo phlox.

Conservation status.—*Phlox vermejoensis* is estimated to be Vulnerable (VU D1+2) according to IUCN Red List criteria (IUCN 2001). It is known from two meta-populations with a total population size (number of clonal clumps) estimated at 500–1,000 individuals, and a total area of occupancy estimated at less than 5 acres (2 hectares). Trends in population size are unknown but presumed to be stable. There are no known, direct, impacts from human activities. Climate change poses a possible long-term threat since the populations lie near ridge crests where upslope migration is limited. Rocky Mountain Elk (*Cervus elaphus* L.) were frequently observed grazing on adjacent areas of flat, alpine turf; however, they usually avoid the scree slopes where *P. vermejoensis* grows.

Additional specimens examined: **U.S.A. New Mexico: Taos Co.:** Vermejo Park Ranch, crest of spur ridge extending NE from point 12827, 3.0 air mi SW of State Line Peak, 36.95704° N, 105.31961° W, elev. 12,460 ft, 13 Jul 2008, *B. Legler 9736* (COLO, KSC, RM, UNM); Vermejo Park Ranch, S side of an unnamed cirque 3.3 air mi SSW of State Line Peak, 36.95208° N, 105.3193° W, elev. 12,430 ft, 20 Aug 2008, *B. Legler 10982* (KSC, RM, UNM, WTU); Vermejo Park Ranch, crest of spur ridge extending NE from point 12827, 3.0 air mi SW of State Line Peak, 36.95686° N, 105.32069° W, elev. 12,520 ft, 18 Jul 2009, *B. Legler 11465, with J.M. Porter & D. Hyder* (RM, UNM, VPR); Vermejo Park Ranch, north slope of spur ridge extending NE from point 12827, 2.95 air mi SW of State Line Peak, 36.95782° N, 105.31901° W, elev. 12,200 ft, 18 Jul 2009, *B. Legler 11468, with J.M. Porter & D. Hyder* (ARIZ, MO, RM); Vermejo Park Ranch, crest of ridge on S side of an unnamed cirque 3.3 air mi SSW of State Line Peak, 36.95159° N, 105.31834° W, elev. 12,620 ft, 21 Jul 2009, *B. Legler 11519* (ARIZ, COLO, MO, RM, UNM, WTU).

DISCUSSION

The distinctiveness of *Phlox vermejoensis* is such that its relationship to other members of the genus could not be ascertained based on morphology alone. It is therefore unlikely to be confused with any other species. Superficially, it resembles the more northerly species *P. alyssifolia* Greene in appearance and leaf shape, but differs in its rhizomatous growth form, lack of cartilaginous leaf margins, shorter style (styles 6–11 mm in *P. alyssifolia*), and distribution and habitat. *Phlox vermejoensis* shares a low, rhizomatous habit with *P. dispersa* Sharsmith, an apparently unrelated species found in granitic scree in the Sierra Nevada Mountains of California that has smaller, pungent, subulate leaves, smaller, solitary flowers, and styles less than 3 mm long. In the monograph by Wherry (1955) it keys most easily to the rhizomatous species in subsect. *Cluteana* of sect. *Phlox*. However, as Wherry freely admitted, this subsection is artificial. Furthermore, *P. vermejoensis* differs substantially in growth form and floral characters from the two species in subsect. *Cluteana*, both of which have corolla tubes much longer than the calyx and styles 12–20 mm long. Attempts to place *P. vermejoensis* into other

sections and subsections defined by Wherry are just as unsatisfactory and would be of limited value in determining affinities due to the highly artificial nature of Wherry's classification (Ferguson & Jansen 2002).

It is unreasonable to treat *P. vermejoensis* as a spontaneous hybrid due to the size of the populations, the presence of apparently viable seeds, and the lack of potential parent species in the vicinity. The only other species of *Phlox* recorded nearby was *P. pulvinata* (Wherry) Cronq., a densely caespitose, subulate-leaved plant found on adjacent areas of dry, alpine turf.

Preliminary, unpublished ITS and cpDNA maximum parsimony phylogenies of western species of *Phlox* by C. Ferguson (pers. comm.) place *P. vermejoensis* within a clade comprised of other southwestern species, with weak support. In the ITS phylogeny, *P. vermejoensis* is sister to a clade including *P. amabilis* Brand, *P. caryophylla* Wherry, *P. cluteana* A. Nels., *P. nana* Nutt., *P. tenuifolia* E.E. Nels., and *P. woodhousei* (A. Gray) E.E. Nels. Support for the overall clade (i.e., including *P. vermejoensis*) is weak (bootstrap <50%). In the cpDNA phylogeny, *P. vermejoensis* falls within a poorly supported polytomy (bootstrap <50%) that includes a subset of the ITS southwestern clade (*P. amabilis*, *P. caryophylla*, and *P. woodhousei*), along with some samples of *P. stansburyi* (Torr.) A. Heller, *P. longifolia* Nutt., and several caespitose to pulvinate species. Further sampling of DNA regions and phylogenetic analyses will be needed to better infer relationships of *P. vermejoensis* within the genus. Presently, no close affinity to a single taxon is apparent.

Given morphology and available DNA information, it may be useful to compare the new species with *P. cluteana*, *P. nana*, and *P. woodhousei*. From all three of these, *P. vermejoensis* differs in its short, tufted stems (1–4 cm high vs. (5–)10–30 cm), shorter leaves (6–25 mm vs. 20–50 mm), smaller inflorescences (1–4(–6) flowers vs. (3–)6–12 flowers), shorter pedicels (1–4 mm vs. 3–30 mm), and habitat (alpine scree vs. open woods and lower slopes). From *P. cluteana*, it further differs in corolla tube length (8–11 mm vs. 15–18 mm), and style length (3.5–6 mm vs. 12–18 mm). *Phlox nana* and *P. woodhousei* both have shorter styles (1.5–3.5 mm). It is further distinguished from *P. nana* by sepal length (8–11 mm vs. 10–16 mm), corolla tube length (8–11 mm vs. 12–18 mm), and smaller corolla lobes. Flower color in *P. cluteana* is purple, while *P. nana* varies from purple to lilac, pink, white, or yellow, and in *P. woodhousei* the color is purple to pink.

Regardless of relationships, *P. vermejoensis* can readily be separated from other members of the genus by the combination of rhizomatous habit, short, tufted stems, broad, non-pungent leaves mostly 2.5–5 times as long as wide, glandular-pubescent inflorescences, corolla tube equal in length to the calyx, styles 3.5–6 mm long and positioned below the anthers, and, usually, a single seed per capsule.

Although capsules with mature, apparently viable seeds were found, several characteristics suggest that *P. vermejoensis* may rely primarily on vegetative dispersal. First, the rhizomatous habit allows it to readily spread through scree and could facilitate downslope dispersal via rhizome fragments. Second, pollen viability appears to be low, with 60.4% (±6.4 std. dev.) of pollen grains failing to stain with cotton blue. Some pollen grains have very irregular, non-reticulate exine sculpting, while, in others the reticulum is tight and dense, with very small lumina and very thick muri. These irregular forms often have thinner walls and tend to collapse. The irregular size, development, and high infertility of the pollen suggest chromosomal pairing irregularities (J. Mark Porter, pers. comm.). Third, the presence of only a single mature seed per capsule may indicate low seed set. Lastly, its narrow distribution and absence from other, nearby scree slopes is unusual since there is no indication that the species is restricted to a particular rock type.

Despite a separation of only 0.5 miles, plants from the southern metapopulation tend to have larger leaves, larger inflorescences, and a later phenology. This difference may be environmentally influenced since the northern sites are slightly drier and more exposed. The type collection, taken from the southern metapopulation, displays the largest observed leaf and inflorescence sizes and illustrates the expected potential of the species.

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BOOK REVIEW

Mark V. Lomolino, Brett R. Riddle, Robert J. Whittaker, and James H. Brown. 2010, **Biogeography, Fourth Edition.** (ISBN-10: 0878934944, ISBN-13: 978-0878934942, hbk.). Sinauer Associates, Inc., 23 Plantree Road, Sunderland, Massachusetts 01375, U.S.A. (**Orders:** orders@sinauer.com). $105.95, 764 pp., 503 illustrations (diagrams, charts, tables, maps, NASA photographs), glossary, bibliography, index, 11¼" × 8 ⅝".

The cover of the book visually compels you to learn more about the subject of biogeography. It is a broad study, but this book encompasses and enlightens you starting with the historical foundations gleaned from the rich legacy of generations of naturalist explorers guided by only crude maps, compasses, and sextants. The authors have applied the most recent technological advances, including geo-statistics, remote sensing, and satellite imagery. This tome redefines the dynamic geography of humanity which continues to shape the geography of nature. *Biogeography* was written primarily as a college text, but it is also an invaluable reference for biogeographers, ecologists, evolutionary biologists, and conservation biologists. It starts with simple facts and principles and assuming only a rudimentary knowledge of biology, geography, and Earth history, explains the relationships between geographic variation in biodiversity and the geological, ecological, and evolutionary processes that have produced them. *Biogeography* is written in an easy-to-read style, defining all new terms. It emphasizes the interplay between unifying concepts and presents evidence that supports or challenges these concepts. Color illustrations are evaluated and optimized for the colorblind readers. The authors were very thorough in their presentation with all of the illustrations, diagrams, charts, tables, maps, photographs, extensive glossary, index, and bibliography. And they have substantially enhanced the depth of coverage of classical foundations, empirical case studies, and frontiers of biogeography. I highly recommend *Biogeography* as an excellent resource for anyone interested in the field.—*Martha Mullens, Master Naturalist, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

A NEW HEDGE-NETTLE (*STACHYS*: LAMIACEAE) FROM THE SOUTHERN APPALACHIAN MOUNTAINS

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ABSTRACT

A new hedge-nettle species (*Stachys*: Lamiaceae) is described from the Southern Section of the Blue Ridge Physiographic Province of the Southern Appalachian Mountains. **Stachys appalachiana** is a narrow endemic known from northwest North Carolina and southwest Virginia. A key for separating morphologically and geographically related taxa is provided, as well as photographs demonstrating the diagnostic characteristics of this new taxon.

ZUSAMMENFASSUNG

Eine neue Ziest-Art (*Stachys*: Lamiaceae) aus der südlichen Sektion der physiographischen Blue-Ridge-Provinz der südlichen Appalachen wird beschrieben. **Stachys appalachiana** ist ein Endemit, der ausschließlich aus dem Nordwesten North Carolinas und dem Südwesten Virginias bekannt ist. Ein Schlüssel zur Bestimmung morphologisch und geographisch verwandter Taxa sowie Fotos der diagnostischen Merkmale der neuen Art werden präsentiert.

RESUMEN

Se describe una nueva especie de ortiga muerta (*Stachys*: Lamiaceae) de la parte sur de la provincia fisiográfica de Blue Ridge del sur de los Montes Apalaches. **Stachys appalachiana** es un endemismo restringido que se conoce del noroeste de Carolina del Norte y suroeste de Virginia. Se ofrece una clave para separar taxa morfológica and geográficamente relacionados, así como fotografías que muestran las características diagnósticas de este nuevo taxon.

There are approximately forty-five native and naturalized species of hedge-nettles (*Stachys* L., Lamiaceae) in North America. The southeastern United States harbors nearly twenty species, with high levels of diversity centered in and around the southern Appalachians, and along the Atlantic Coast (Nelson 2008; Weakley 2011). Continued studies in the genus by the second author have revealed various cryptic taxa, including *Stachys iltisii* J.B. Nelson (Nelson 2008) and *S. matthewsii* G.P. Fleming, J.B. Nelson & J.F. Townsend (Fleming et al. 2011). Recent investigations into an enigmatic taxon first discovered in the Blue Ridge Mountains in 1974 indicate that an additional species should be recognized.

Stachys appalachiana D.B. Poindexter & J.B. Nelson, sp. nov. (**Figs. 1, 2 G–H, 3**). Type: UNITED STATES. North Carolina. **Ashe Co.:** Fleetwood, along US Hwy 221, moist roadside along the South Fork of the New River, 23 Jul 1974, *J.B. Nelson 294* (holotype: NCU!; isotypes: CLEMS!, NY!).

A *Stachyde latidente* et *S. hispida* et *S. eplingii* pubescentia caulina densa, lobis calycis lanceolatis patentibus, trichomatibus caulinis calycinisque glandulosis longis ad sessilibus necnon eglandulosis longis vel brevibus differt.

Perennial **herbs** usually 1–2 m tall from pale slender rhizomes, often in colonies of 5–10 individuals. **Stems** hollowed toward the base, especially on larger plants, which generally feature dead/shriveled leaves by late summer at the lowest nodes, bases and foliage also commonly moldy/mildewed by mid-late growing season; stems erect to reclining, containing soft, white pith distally; stems sparingly branched, and then from the upper one or two sterile nodes; **stem faces** commonly sunken, especially toward the base, thus forming U-shaped troughs between the angles, glabrate to sparsely pubescent with an admixture of primarily sessile, atomiferous glands and rarely stipitate glands that increase in abundance distally and just below the nodes, seldom exhibiting a few cylindrical, multicellular trichomes, which also become more common distally and at the base of the

Fig. 1. *Stachys appalachiana* (based on *D.B. Poindexter 09-739*, BOON). A) Erect hairs of the adaxial leaf surface, B) densely hispid stem pubescence, and C) inflorescence.

stem; **stem angles** often rounded, densely pubescent with sessile glands, flattened, small one-celled stipitate glandular hairs and taller 2- to 3-celled gland-tipped flexuous trichomes, and longer, 3(–4) cylindrical-celled eglandular hairs with pointed tips and a spreading orientation, ranging from (1.5–)2–2.5(–3) mm in length with a broad basal cellular complex; **nodes,** especially the lower, densely bearded-pubescent with straight, multi-celled eglandular hairs, these ascending, spreading and retrorse, or often flattened during pressing. **Leaves** narrowly elliptic to ovate-elliptic, broadest toward middle, 8–12 x 3.5–5 cm, spreading, densely pubescent on the prominently rugose adaxial surfaces with mostly erect (antrorsely appressed in specimens) eglandular hairs, and moderately to densely pubescent (especially along the veins) on abaxial surfaces with long (stiffly erect-spreading) hairs and occasional short to sessile glandular trichomes, pubescence density increasing on leaves on distal portions of the plant, base cordate to truncate, apex acute to broadly acuminate, margin crenate-serrate with 2–3 teeth per cm, highest point of each tooth terminating a veinlet, tooth margins ciliate with spreading eglandular and stipitate glandular hairs, petioles 5–6 mm long (very rarely up to 1 cm on lower stem leaves), pubescent with eglandular and stipitate glandular hairs. **Inflorescences** commonly elongated at maturity, and densely pubescent on all faces; bracts more or less three-veined from base, rapidly reduced distally from highest sterile node, or the first one or two fertile nodes with somewhat leafy, toothed bracts; upper (distal) bracts trullate to ovate, densely ciliate; **axillary cymules** each with (3–)4(–5) flowers, verticils thus (6–)8(–10) flowered, bractlets of flowers spinulose, bristly-pubescent. **Flowers** bisexual and predominately fertile; **calyces** actinomorphic, calyx of fully opened flowers 5.7–6 mm long, tube 3–4 mm long, lobes approximately half the length of the tube, 2.0–2.4 mm long, narrowly deltoid to lanceolate at maturity, each lobe terminated with a pale, spinose tip ca. 0.1–0.2 mm long; calyx tube and lobes generally densely pubescent on the outer surface with long flexuous stipitate glandular hairs, frequent stiff hairs, and occasional sessile to subsessile glandular trichomes, less pubescent to glabrate on the inner surface, with glandular and eglandular trichomes; lobes commonly ciliate with stipitate glandular hairs, flared at anthesis and becoming somewhat

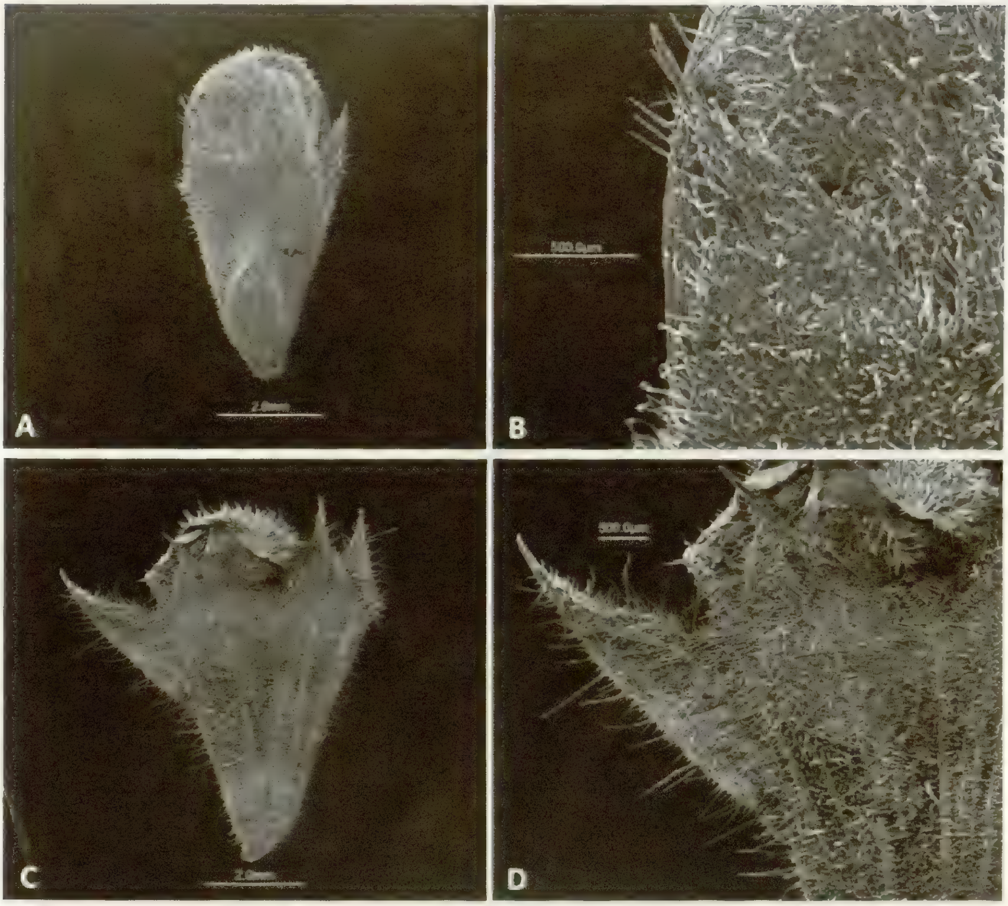

Fig. 2. SEM images of *Stachys* calyces. A–B) *Stachys latidens* (*D.B. Poindexter 05-1287*, BOON) exhibiting narrowly deltoid lobes and short stipitate glandular pubescence. C–D) *Stachys eplingii* (*T.F. Wieboldt 9461*, USCH) with broadly deltoid lobes and a mixture of eglandular and short stipitate to atomiferous glandular hairs.

spreading (recurved) with mature fruit; **corollas** tubular, 10–12 mm long from the base to the tip of the upper lip (galea); tube bright pink, pubescent with appressed eglandular hairs, 7–8 mm long, saccate toward the base on the ventral side, glabrous internally except for a pronounced oblique annulus comprised of soft-flexuous, somewhat clavate flattened hairs, its basal point just posterior to the pouch; galeae up to 3.5 mm long and nearly solid pink, usually rounded, but occasionally emarginate apically, surface with eglandular multicellular hairs and margins with both eglandular and long stipitate glandular trichomes; lower lip declined 80°–90° at full anthesis, 5–6 mm long, featuring prominent pink-purple blotches and lines on a pale background, with greater concentrations of anthocyanins along the margins, abaxially with a patch of eglandular trichomes. **Mericarps** dark brown, 1.6–2 mm x 1.2 mm, minutely verrucose, often with fungal hyphae that appear as trichome-like projections.

Additional specimens seen: **UNITED STATES. NORTH CAROLINA. Alleghany Co.:** near Edmonds, 0.26 km N of NC Hwy 18, over ultramafic substrate, 8 Jul 2009, *D.B. Poindexter 09-739* (BOON); same location, 10 Aug 2009, *D.B. Poindexter 09-909* (BOON). **Watauga Co.:** roadside-field border, 1.7 mi SE of Boone on US 321-221, 25 Jul 1958, *H.E. Ahles 47582* (NCU). **VIRGINIA. Carroll Co.:** E side of US 221, ca. 0.25 mi N of jct. with US 58 on NE side of Hillsville, 18 Jul 1995, *J.B. Nelson 16753* (USCH); same location, 18 Jul 1996, *J.B. Nelson 17583*

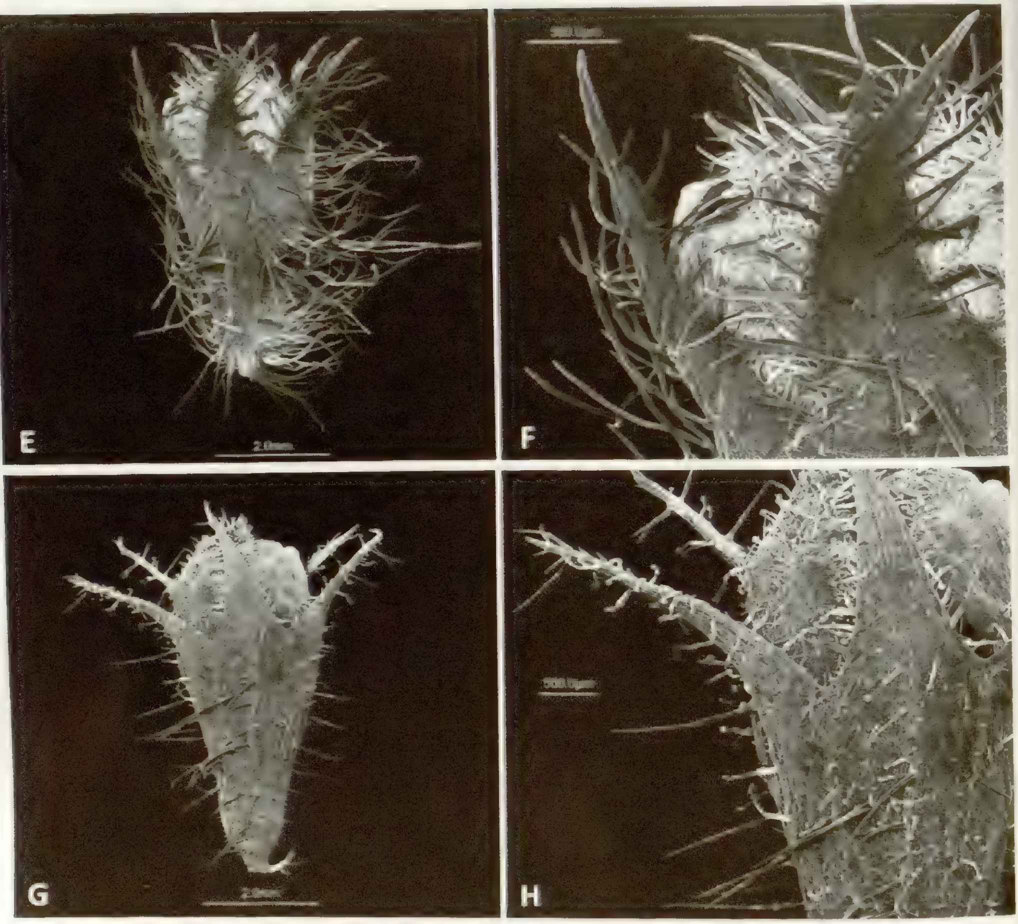

Fig. 2 (continued). SEM images of *Stachys* calyces. E–F) *Stachys hispida* (*D.B. Poindexter 05-1287*, BOON) demonstrating erect, narrowly lanceolate lobes densely covered in long hispid trichomes and sparse sessile glands. G–H) *Stachys appalachiana* (*D.B. Poindexter 09-790*, paratype, BOON) with characteristic flaring, narrowly lanceolate lobes and a mixture of long to sessile glandular and eglandular hairs.

(USCH). **Floyd Co.:** bog near intersection of Blue Ridge Parkway and Rt. 639, 22 Jun 1981, *D.W. Ogle s.n.* (VPI). **Grayson Co.:** bog on Meadow Creek, W of Rt. 622, just N of jct. of Rt. 617, 31 Aug 1982, *D.W. Ogle s.n.* (VPI); same location, 19 Jul 1994, *J.B. Nelson 16770* (USCH); same location, 16 Jul 2009, *D.B. Poindexter 09-789* (BOON); same location and date, *J.B. Nelson 27699* (USCH); Parson's Bog near Baywood, 2 Jul 1983, *D.W. Ogle s.n.* (VPI); W side of Meadow Creek on the E side of Delhart Rd. (VA 622), 1.05 mi SE of US 58, 16 Jul 2009, *J.B. Nelson 27697* (USCH); same location and date, *D.B. Poindexter 09-790* (BOON).

DISCUSSION

Distribution and Habitat.—Stachys appalachiana is a narrow endemic restricted to a few populations in the Southern Blue Ridge Physiographic Province (Fenneman 1938) of the Southern Appalachian Mountains (sensu Braun 1950). Collections of this taxon have been made in only six counties, Alleghany, Ashe, and Watauga, NC, and Carroll, Floyd, and Grayson, VA (Fig. 4). This species should also be sought in neighboring montane counties.

It is well known that the southern Appalachians harbor a wealth of rare taxa, comprised of both northern species that have been able to persist in this region following Pleistocene glacial recession, and other taxa that

FIG. 3. Holotype of *Stachys appalachiana* (*J.B. Nelson 294*, NCU).

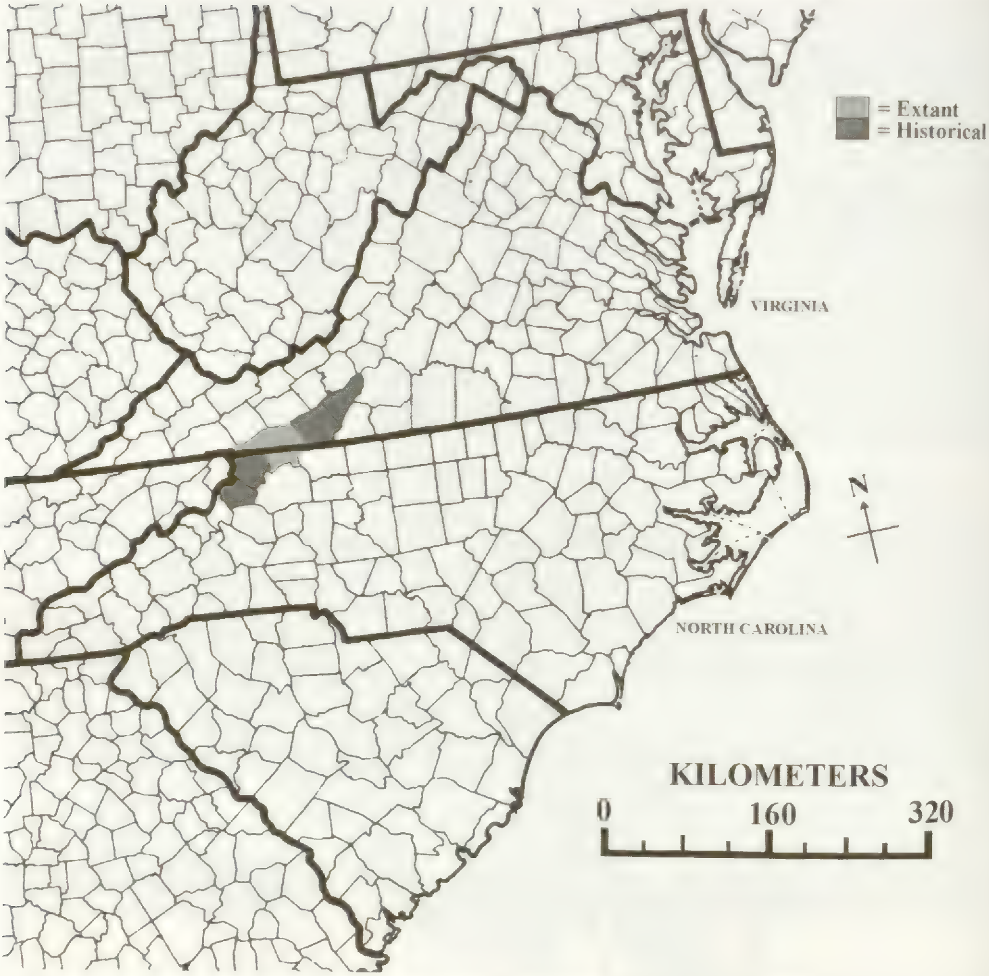

FIG. 4. Current and historical distribution of *Stachys appalachiana*.

are endemic to this area (Harper 1947; Wood 1970; Murdock 1994; Pittillo 1994). Species-level endemism in *Stachys* of the southern Appalachians is not novel. *Stachys clingmanii* Small was described from Clingman's Dome in the Great Smoky Mountains and is also endemic to the same physiographic area, yet not sympatric with *S. appalachiana* (Small 1903; Weakley 2011). *Stachys latidens* Small ex Britton is also primarily confined to the southern Appalachians and rarely occurs in adjacent Piedmont regions. It is not the purpose of this paper to provide a discourse on southern Appalachian endemism, but it is interesting to note that other cryptic endemics have been recently described from comparable taxonomically difficult genera (e.g., *Eutrochium steelei* (E.E. Lamont) E.E. Lamont) (Lamont 1990).

Stachys appalachiana is found primarily in open bogs and fens, exhibiting an apparent affinity for soils derived from mafic or ultramafic substrates, although not restricted to these soils. It is also known from wet areas and flood plains near or adjacent to tributaries with ample sunlight. In ideal habitats, *Stachys appalachiana* may become quite tall, leaning upon surrounding vegetation. Most associates are somewhat ubiquitous (e.g., *Eutrochium fistulosum* (Barratt) E.E. Lamont, *Lyonia ligustrina* (L.) DC. var. *ligustrina*, *Phalaris arundina-*

cea L., *Salix sericea* Marshall, *Rubus pensilvanicus* Poir., *Teucrium canadense* L., and *Verbesina alternifolia* (L.) Britton ex Kearney). However, this species has been noted by the authors to co-occur with other uncommon taxa in the southern Appalachians, such as *Campanula aparinoides* Pursh var. *aparinoides*, *Calamagrostis canadensis* (Michx.) P. Beauv. var. *canadensis*, *Carex trichocarpa* Muhl. ex. Willd., *Filipendula rubra* (Hill) B.L. Rob., *Galium asprellum* Michx., *Lilium canadense* L. var. *editorum* Fernald, *L. grayi* S. Watson, *Thalictrum macrostylum* Small & A. Heller, and *Veronicastrum virginicum* (L.) Farw. Flowers of *Stachys appalachiana* are visited by numerous insect species including honeybees and other hymenopterans. Like other hedge-nettles (and many other labiates), mericarps of this species are often susceptible to frugivory by the hemipteran *Sehirus cinctus* (P. Beauv.) (Sites & McPherson 1982).

Taxonomic Distinctiveness.—Taxonomic delineations in *Stachys* have been primarily based on morphological characters such as calyx lobe shape (deltoid vs. lanceolate), petiole lengths of mid-stem leaves, number of flowers per verticil, and pubescence patterns of the calyx, stem faces (of the uppermost sterile internode), and stem angles (e.g., Small 1903; Mulligan & Munro 1989; Nelson 2008; Weakley 2011).

Stachys appalachiana is distinctive in its combined possession of a wetland habitat preference, leaf blades elliptic, crenate to serrate, flowers 8–10 per verticil, calyx lobes lanceolate flaring (with long flexuous glandular and stiff eglandular hairs), adaxial leaf surfaces with very abundant, soft erect hairs, abaxial leaf surfaces sparingly stipitate glandular, stem angles with prominent and abundant stiff and retrorse hairs (including long stipitate glandular hairs), and stem faces glabrate with relatively few glandular or eglandular trichomes (Figs. 1–2).

Stachys eplingii J.B. Nelson and *S. latidens* are sympatric with *S. appalachiana*, while the more geographically removed *S. hispida* Pursh has been most frequently confused with this new species. These four entities are distinguished with comparative ease.

Calyces of all four taxa differ in pubescence patterns and lobe shape (Fig. 2). More specifically, *Stachys eplingii* and *S. latidens* generally exhibit broader, more deltoid calyx lobes, with a primarily short stipitate glandular pubescence (*S. eplingii* also possesses spreading eglandular trichomes). *Stachys appalachiana* and *S. hispida* have demonstrably more strongly lanceolate calyx lobes, with *S. appalachiana* characterized by its short to long stipitate glandular trichomes and more thinly distributed hispid eglandular hairs. *Stachys hispida* lacks long stipitate glands (with usually only atomiferous glands if any) and the calyx is predominately cloaked with very long, stiff trichomes. Another prominent character that is highly useful for segregating these congeners from *Stachys appalachiana* is pubescence patterns of the adaxial leaf surface. *Stachys appalachiana* invariably demonstrates an erect and substantial pubescence (Fig. 1), while its counterparts have appressed and typically less abundant trichomes.

The following discussion outlines the salient features of the aforementioned sympatric and/or morphologically similar species that could be confused with *Stachys appalachiana* (see Table 1 for comparison). *Stachys eplingii* is a plant of wetlands, with leaf blades ovate, crenate-crenulate, flowers 8–10 per verticil, calyx lobes deltoid, abaxial leaf surfaces exhibiting a heavily short stipitate glandular pubescence, stem angles prominently pubescent with spreading and retrorse hairs, and with stem faces consistently and densely short stipitate or otherwise glandular pubescent. *Stachys hispida* may occur in a variety of habitats, with leaf blades elliptical, serrated, flowers 6 per verticil, calyx lobes lanceolate, abaxial leaf surfaces never glandular, stem angles prominently long pubescent, and stem faces glabrous (or occasionally with very sparse sessile glands). *Stachys latidens* can be found in dry-mesic, open to forested habitats, with leaf blades elliptical, serrated, flowers 6 per verticil, calyx lobes deltoid, abaxial leaf surfaces scarcely or never glandular, stem angles featuring relatively short retrorse, eglandular broad-based trichomes, and stem faces largely glabrous or with sparse sessile glands.

Conservation Status.—Five populations were visited in the summers of 2009 and 2010. Plants from at least two of the older collection sites, specifically those from Ashe Co., NC (type locality) and Carroll Co., VA are no longer extant. Only three sites of the five areas visited have confirmed viable populations that seem to be thriving and healthy. These sites include two areas along Delhart Rd. (SR 622; Grayson Co., VA) and the newly discovered population at Savannah Church Bog (Alleghany Co., NC). Other cited populations from Watauga Co.,

TABLE 1. Comparison of sympatric and morphologically similar species of *Stachys*.

Character	*S. latidens*	*S. eplingii*	*S. hispida*	*S. appalachiana*
Distribution	Broadly Southern Appalachian, mostly at mid- to high elevation, rare in the Piedmont, GA-PA	Sporadic in the Southern and Central Appalachians, WV, VA (rare in w NC)	Rare in the NC. Mainly lowlands, Piedmont and Ridge and Valley	Narrow endemic of mid-elevations in the Southern Appalachians (sw VA and nw NC)
Habitat	Upland forests and clearings	Wetlands	Various	Wetlands
Leaf blades	Serrate	Crenate-crenulate	Serrate	Crenate to serrate
Stem faces	Glabrous or with sparse sessile glands	Densely short stipitate glandular	Glabrous or with sparse sessile glands	Glabrate with scattered glandular and eglandular trichomes
Stem angles	Short retrorse, broad-based eglandular trichomes	Spreading and retrorse eglandular trichomes, and often short stipitate glandular trichomes	Long spreading-retrorse eglandular trichomes	Long, mostly retrorse trichomes and long flexuous and short stipitate glandular trichomes
Calyx lobes	Deltoid to deltoid-lanceolate, erect	Broadly deltoid, erect	Lanceolate, erect	Lanceolate, flaring
Calyx pubescence	Short stipitate glandular to glabrate	Densely short stipitate and sessile glandular, with hispid eglandular trichomes	Densely long eglandular trichomes, sparse sessile glands	Long stipitate and short to sessile glandular, with hispid eglandular trichomes
Flowers/verticil	6	8–10	6	8–10

NC, and Grayson Co., VA, were not investigated, and may still be present. Future monitoring is imperative, especially considering the observed population extirpation at some historic sites.

Since only three populations are currently known to be extant, this taxon should be provisionally treated as S1 or "critically imperiled" on a State Rank Status basis in both NC and VA. Furthermore, *Stachys appalachiana* should tentatively receive the Global Rank Status of G1 or "critically imperiled" (as defined in Buchanan & Finnegan 2010).

Nomenclature.—As alluded to by the specific epithet, "Appalachian Hedge-nettle" seems to be an appropriate colloquial name for this entity.

Etymology.—The sparse distribution of this plant in the Blue Ridge Physiographic Province of the Southern Appalachians, and the fortuitous availability of "*appalachiana*" are responsible for the applied epithet.

KEY TO *STACHYS APPALACHIANA* AND MORPHOLOGICALLY AND GEOGRAPHICALLY RELATED SPECIES
(modified from Nelson 2008 and Weakley 2011)

1. Petioles well-developed (mid-stem leaves with petioles typically greater than 15 mm), 1/3 or more the length of the blade.
    2. Calyx tube and lobes with few or no glandular hairs.
        3. Upper stems slender, commonly branched, stem angles glabrous to sparsely pubescent; calyx glabrous to sparsely pubescent, lobes commonly recurved in fruit; ____ **S. tenuifolia** Willd.
        3. Upper stems slender to stout, mostly unbranched unless injured, stem angles hispid to hispidulous; calyx hispid to hispidulous, lobes generally straight in fruit.
            4. Leaf blade base truncate; stem pubescence spreading; high elevation (ca. 1000–2020 m) ____ **S. clingmanii**
            4. Leaf blade base rounded; stem pubescence mostly retrorse; low to middle elevations (ca. 100–800 m) ____ **S. hispida** (long-petioled forms)
    2. Calyx tube and lobes with abundant sessile and/or stipitate glandular hairs.

5. Leaf blades dentate or nearly so; blade apices acuminate ____ **S. clingmanii**
5. Leaf blades serrate to crenate-serrulate; blade apices acute.
6. Mid-stem leaf blades ovate to broadly ovate, base cordate, margins crenulate ____ **S. cordata**
6. Mid-stem leaf blades elliptic-oblong, base rounded to slightly cordate, margins crenate to serrate ____ **S. nuttallii** Shuttlew. ex Benth.
1. Petioles short (mid-stem leaves with petioles typically less than 15 mm) to essentially absent.
7. Stem angles conspicuously pubescent with long spreading and/or retrorse eglandular hairs.
8. Calyx lobes lanceolate, about ½ length of tube.
9. Upper stem faces, inflorescence axis, and calyx moderately or densely glandular-pubescent; calyx lobes spreading/flaring in fruit; flowers 8–10 per verticil ____ **S. appalachiana**
9. Upper stem faces and inflorescence axis glabrous, calyx with none or very few glandular trichomes, if present, mostly restricted to calyx lobes; flowers 6 per verticil ____ **S. hispida**
8. Calyx lobes deltoid, less than ½ length of tube.
10. Stem faces glabrous, angles mostly spreading eglandular pubescent ____ **S. matthewsii**
10. Stem faces pubescent, angles often spreading and/or glandular pubescent.
11. Leaf blades ovate to lanceolate; flowers 8–10 per verticil ____ **S. eplingii**
11. Leaf blades elliptic; flowers 6 per verticil ____ **S. nuttallii** (short-petioled forms)
7. Stem angles glabrate or inconspicuously pubescent, pubescence restricted to short, retrorse eglandular hairs.
12. Leaf margins serrate-crenate; inflorescence bracts abruptly reduced upward from first flowering verticil, never foliose ____ **S. latidens**
12. Leaf margins sharply serrate; inflorescence bracts gradually reduced upward from first flowering verticil, thus foliose ____ **S. subcordata** Rydb.

Second Author's note.—In the summer of 1974 I was a brand new graduate student at Clemson University, having been taken under the care and direction of John E. Fairey, III. My experience with hedge-nettles up to that point had been limited to seeing herbarium specimens and images in publications, and I was thrilled to take part in one of Professor Fairey's pilgrimages to Morgantown and West Virginia University. Our trip in July of that summer thus had two aims: Fairey's reconnoitering and some business with his former professor, Earl Core, and my collecting hedge-nettles (among other things). Interestingly, Core had located a hedge-nettle in Pocahontas County, West Virginia that he was saving for me, a plant eventually described as a new taxon, *Stachys eplingii*.

The morning of July 23 surely broke bright and beautiful at Clemson, and we reached Ashe County well after lunch-time. On not much more than a whim, we parked along the side of US 221 (at what I mistakenly indicated was the New River proper, but was actually the South Fork of the New River) to botanize. The scent of mowed hay, the sound of meadowlarks, and the gorgeous mountain scenery had me in a trance...and by golly, there was a hedge-nettle down there in the grass, a big, pink-flowered, profoundly hairy one. (In retrospect, it seems that the type locality was very degraded habitat, no doubt what was left of a meadow bog, now the base of a road shoulder at a cow pasture.)

So there it was: my first hedge-nettle in the field, and what has turned out to be a new species. I'm not sure if this little story has a moral attached to it, but there are at least two messages. The first is one we keep hearing, in that the need for botany is far from over, and that there are plenty of discoveries yet to be made in our own back yards. The second message is for students, young or old, who have chosen to study botany: hold tightly to the excitement and interest you have for plants, for you have embarked on a marvelous journey of discovery!

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A NEW SPECIES OF *ERIGERON* (ASTERACEAE) FROM SOUTHWESTERN OREGON

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ABSTRACT

Erigeron stanselliae K.L. Chambers, sp. nov., is a narrowly endemic species of serpentine sites in the Coast Range of southwestern Curry County, Oregon. A member of the taxonomically difficult *E. eatonii* sens. lat. alliance, its known range is disjunct from related taxa in the complex, including *E. robustior, E. maniopotamicus, E. lassenianus*, and *E. eatonii* var. *plantagineus*.

RESUMEN

Erigeron stanselliae K.L. Chambers, sp. nov., es una especie endemica de las serpentinas en la Cordillera Costera del suroeste de Curry County, Oregón. Un miembro del taxonomicamente difícil del grupo *E. eatonii* sens. lat., su area conocida es disyunta con los taxa relacionados del complejo, incluyendo *E. robustior, E. maniopotamicus, E. lassenianus*, y *E. eatonii* var. *plantagineus*.

DESCRIPTION

Erigeron stansellii K.L. Chambers, sp. nov. (**Figs. 1–2**). TYPE: U.S.A. OREGON. Curry Co.: Flycatcher Spring, U.S. Forest Service Road 1703 off Hunter Creek Road, T.37S., R.13W., Sect. 19, elev. 744 m, gravelly serpentine soil on roadside flat, mixed shrub/woodland, with *Pinus jeffreyi, P. attenuata, P. monticola, Quercus vaccinifolia, Arctostaphylos nevadensis*, 20 Jun 2009, *K.L. Chambers 6447* (HOLOTYPE: OSC 226910; ISOTYPES: BRIT, NY, UC).

Species ad *E. eatonii* gregem affinis a *E. eatonii* var. *plantagineo* involucro minute glandulifero foliis caulibus distaliter paucistrigosis differt, a *E. maniopotamico* involucro minute glandulifero foliis glabris vel paucistrigosis differt, a *E. robusto* altitudine breviore capitulis minoribus involucro minute glandulifero differt, a *E. lasseniano* foliis glabris vel paucistrigosis pedunculis 5–10 cm longis distaliter modice glanduliferis et strigosis differt.

Plants perennial, tap-rooted, taproot slender, 1–3 mm diameter, surface striate, caudices short (rarely elongate), 1–3 surmounting taproot, surface striate or corky. **Stems** simple or 1(rarely 2–3)-branched medially, erect or decumbent, 7–25 cm, glabrous or sparsely strigose, leafy 0.3–0.8 times length, distal peduncle leafless, (3–) 5–10 cm, glabrous or sparsely strigose, minutely glandular beneath the head. **Principal leaves** in a basal rosette, entire, linear to narrowly oblanceolate, mostly 1-nerved, 4–12 cm long, 2–5 mm wide, glabrous or sparsely strigose, cauline leaves 4–8, 0.25–0.33(–0.7) times basal, gradually or promptly reduced distally, linear to narrowly elliptic, 0.5–4 cm long, glabrous or loosely strigose on both surfaces, with unicellular or few-celled, sharply pointed trichomes. **Heads** 1–2(–4) per stem, held well above leaves, involucres 5–6(–7) mm high, 5–10(–11) mm wide (pressed), phyllaries in 2–3 equal or subequal series, linear-lanceolate, acute to acuminate, 1-nerved, margins green (on outer) or narrowly scarious (on inner phyllaries), loosely or densely white-pilose to strigose dorsally, with under layer of minute glandular pili (Fig. 2). **Ray florets** 14–36, corollas 6–10 mm long, 1–1.5 mm wide, white or pinkish, curling abaxially in age. **Disc florets** corollas 3–4 mm, teeth deltate, acute. **Cypselae** 3–4 mm (immature), 2-nerved, sparingly to densely strigose; pappus of 14–24 free, minutely hispid bristles, 2.8–3.0 mm long, with a few short outer setae. Chromosome number: $2n$ = ca. 18.

Additional collections examined: **OREGON. Curry Co.:** Flycatcher Spring, near Red Flat, above the North Fork of the Pistol River, T.37S., R.13W., Sect. 19, 15 Jun 1970, *W.G. Schroeder s.n.* (OSC 132317); McKinley Mine area at Signal Buttes E of Gold Beach, T.37S., R.13W., Sect. 6, serpentine "shingle" with scrub oaks, *Arnica spathulata, Senecio canus, Microseris laciniata*, 23 Jun 1982, *V. Stansell s.n.* (OSC 158310); Flycatcher Spring, Pistol River drainage, T.37S., R.13W., Sect. 19, 6 Jun 2009, *V. Stansell s.n.* (OSC 226909).

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FIG. 1. Habit of *Erigeron stanselliae* (holotype, OSC). Scale = 5.1 cm.

Fig. 2. Capitulum of *Erigeron stanselliae*. Note pubescence of minute glandular trichomes. Scale = 1.25 cm.

Etymology, habitat, and distribution.—named in honor of Veva Stansell, long-time resident botanist of southwestern Oregon, who guided the author to the population from which the type collection was taken. The two known localities for this species, McKinley Mine and Flycatcher Spring, are some 5 km apart, north to south, near the western margin of the Siskiyou National Forest, about 11 km east and 13 km southeast, respectively, from Gold Beach. The habitat is mixed scrubland and woodland, in serpentine gravel or "shingle." Plants are shorter, with decumbent stems, in open sites, erect and taller when growing up through mats of *Arctostaphylos nevadensis* (Fig. 1). Additional associated species, from field notes, include *Chamaecyparis lawsoniana, Juniperus communis, Antennaria suffrutescens, Garrya buxifolia, Ceanothus pumilus, Erigeron foliosus,* and *Polygala californica*. Detailed ecological studies of the habitat have not been done, and population sizes of the species are not known. On the Geological Map of Oregon (U. S. Geological Survey, G.W. Walker and N.S. MacLeod 1991), these sites are in a small area, about 20 km long and up to 5 km wide, comprising ultramafic and related rocks of Jurassic ophiolite sequences, locally altered to serpentinite. There are no exposures of similar ultramafics between this occurrence and the coast, the closest being about 10 km to the east. The near-coastal climate and serpentine substrate may be unique to *E. stanselliae*, although it would be unusual if the

species were limited in distribution to such a small area. There is a gap in range between it and the related taxa *E. maniopotamicus* G.L. Nesom & T.W. Nelson, *E. robustior* (Cronquist) G.L. Nesom [*E. decumbens* ssp. *robustior* Cronquist (1947)], and *E. lassenianus* Greene [including *E. flexuosus* Cronquist (1947)] found in Humboldt and Trinity Cos., California (Nesom & Nelson 2004). The intervening area, particularly in Del Norte Co., might be searched for similar serpentine sites perhaps occupied by *E. stanselliae*. The related *E. eatonii* var. *plantagineus* (Greene) Cronquist is a more inland taxon, approaching *E. stanselliae* from the east only as far as Jackson Co., e.g. *Chambers 4358*, Red Mtn., OSC (Strother & Ferlatte 1988, map pg. 79).

DISCUSSION

I had originally annotated two OSC herbarium collections of the new species as *Erigeron eatonii* var. *plantagineus*. However, in conjunction with his study of this species (Strother & Ferlatte 1988), John Strother later annotated these sheets "not *E. eatonii*, perhaps *E. peregrinus* alliance near *E. cervinus*." In my opinion, *E. stanselliae* does not compare well with the latter two species but is better placed in the *E. eatonii* alliance. To quote from Strother and Ferlatte (1988), "'Crazy-quilt' aptly describes the confounding geographic pattern of sometimes marked and, more often, subtle morphological variants that are subsumed by the phrase '*Erigeron eatonii* and allied taxa.'" *Erigeron maniopotamicus* was added to the complex by Nesom and Nelson (2004), who compared their species with related taxa found in northwestern California and adjacent Oregon (mainly *E. eatonii* var. *plantagineus*, *E. robustior*, and *E. lassenianus*). Key traits used in this comparison were (1) size of heads, (2) presence of caudex branches, (3) phyllaries eglandular or minutely glandular, (4) cauline leaves bracteate or absent near heads, or continuing relatively unreduced to near heads, and (5) phyllary shape and apiculation. The following key, adapted from Nesom and Nelson (2004) and Nesom (2006), best distinguishes *E. stanselliae* from the geographically allied species in this complex:

1. Involucres 6–8.5 mm high, (12–)14–20 mm wide (pressed), phyllaries eglandular ______ **E. robustior**
1. Involucres 4–7 mm high, 5–12(–14) mm wide (pressed), phyllaries minutely glandular or eglandular.
  2. Phyllaries eglandular (sometimes sparsely glandular), leaves usually densely strigose to villous.
    3. Cauline leaves continuing relatively unreduced to near heads; phyllaries elliptic-oblanceolate to oblong-oblanceolate ______ **E. maniopotamicus**
    3. Cauline leaves absent or bracteate near heads; phyllaries narrowly lanceolate to narrowly oblanceolate ______ **E. eatonii var. plantagineus**
  2. Phyllaries minutely glandular, leaves densely strigose to villous or glabrous to sparsely strigose.
    4. Leaves densely strigose to villous, inflorescence branches, if present, mostly distal, cauline leaves often numerous, not much reduced distally, peduncles 1.5–5(–6) cm, usually densely glandular and strigose below heads ______ **E. lassenianus**
    4. Leaves glabrous or sparsely strigose, inflorescences branches, if present, medial, cauline leaves 4–8, gradually or promptly reduced distally, peduncles (3–)5–10 cm, lightly glandular and strigose below heads ______ **E. stanselliae**

Vegetative traits used in these comparisons are affected by age and growth conditions, as shown by plants at the type locality (Fig. 1). All the taxa seem to vary in the degree to which cauline leaves are reduced distally, and the size of the taproot, as well as number of caudex branches, must depend, in part, on plant age. Degree of branching, number of heads per stem, and length of floral peduncles may also reflect age and robustness of growth. Density of leaf and stem pubescence is a notable difference, which may be less affected by conditions of vegetative growth. *Erigeron stanselliae* is the least pubescent in the above group of related taxa; its leaves are frequently glabrous and at the most are lightly strigose with weak trichomes. The stems are also lightly strigose, never densely and stiffly strigose near the apex as in most other taxa. The minute glandular hairs of the stem apex and involucres, in this taxon and in *E. lassenianus*, are only discernable at 20× magnification or higher (Fig. 2). In herbarium specimens they show best on phyllaries at the sides of the head, which were not compressed in the drying process, while on the flattened sides of the heads one finds the basal stumps of broken-off villous trichomes, and these mimic short, non-glandular hairs. In our chromosome preparations, no meiotic cells were present, but a count of approximately 18 was obtained from mitotic divisions in somatic tissue. The diploid number $2n = 18$ is also reported for *E. eatonii* var. *plantagineus* and *E. lassenianus* (Nesom 2006). Polyploidy and apomixis are therefore not indicated for the new species, which is presumed to reproduce only sexually.

Adaptation to serpentine substrates distinguishes *Erigeron stanselliae* from *E. maniopotamicus* (Nesom & Nelson 2004) and *E. eatonii* var. *plantagineus* (Strother & Ferlatte 1988) but not from *E. robustior* or *E. lassenianus*. Its geographical isolation and probable lack of recent hybridization with related taxa of northwestern California are factors in the morphological distinctness and implied species status of *E. stanselliae* as here described.

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BOOK REVIEWS

BARRY G. HALL. 2010. **Phylogenetic Trees Made Easy: A How-To Manual, Fourth Edition.** 2011. (ISBN-13: 978-0-87893-606-9, pbk.). Sinauer Associates, Inc., 23 Plum Tree Road, P.O. Box 407, Sunderland, Massachusetts 01375-0407, U.S.A. (**Orders:** 413-549-4300, orders@sinauer,com). $49.95, 282 pp., 221 illustrations, 9¼" × 7".

The author describes this book as "a 'cookbook' intended to aid beginners in creating phylogenetic trees from protein or nucleic acid sequence data." It should not be used as a stand alone text, but it is a wonderful "how-to" manual of creating and describing the phylogenetic trees produced by inputting molecular data. It provides steps from start to finish on how to build and interpret a tree.

The first few chapters of the book describe the different computer programs (many of which are free downloads) and how exactly to use these programs. Most helpful are the many figures in the book which guides a user through every step. "Click" and "drag" are words commonly used by the author to literally walk a user through the somewhat confusing programs to beginners. Some of the programs that the author uses are BLAST, MUSCLE, ClustalW, MEGA 5, GUIDANCE, and Codeml. Later chapters describe some of the more (in this reviewer's mind) complex diagrams and explanations of the data such as phylogenetic networks and type of directional selection.

The author does go into some detailed explanations in the "Learn More About" boxes found throughout the book. He explains evolutionary models, parsimony, distance methods, Bayesian inference, and others. However, as stated earlier, the author intends this book to be a supplement to a phylogenetics text.

Overall, this is an incredibly helpful book to those trying to reconstruct the evolutionary histories of proteins, species, or populations.—*Sam Kieschnick, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

DAVID M. WILLIAMS AND SANDRA KNAPP, EDITORS. 2010. **Beyond Cladistics or the Branching of a Paradigm.** (ISBN:-10: 0520267729, ISBN-13: 978-0-520-26772-5, hbk.). Species and Systematics Series 3. The University of California Press, Berkeley, CA, c/o California/Princeton, Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A. (**Orders:** phone 1-800-777-4726). $65.00, 330 pp., 14 b/w photos, 47 illustrations, 8 tables, 6" × 9".

The book is prefaced by a remark that, according to Colin Patterson and echoed by Gary Nelson, the cladistics revolution "began in the 1960s, accelerated in the 1970s, and was virtually complete by the eighties". Cladistics is phylogenetic systematics which is a method of discovering, unraveling, and then testing hypotheses of evolutionary history. Even though the broad outlines have been established, this book illustrates that methodologies and techniques are developing as well as being improved. Newer analytical tools and more imaginative uses are also contributing to the development of cladistics. This book is about the future of cladistics and the ways it has and is influencing its future. It is also a tribute to Chris Humphries who is now a major force in its development. In addition to studying the species as a unit (which is comprised of its past, present and future), a new tool, DNA, now brings the species back into the picture. The book is divided into Botany, Cladistics and Biogeography, each with several chapters by various authors. An excellent book with in-depth analysis explaining why cladistics' real value lies in the careful specimen examination and then comparing it to previously described taxa.—*Troy Mullens, Volunteer, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

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AGROSTIS LACUNA-VERNALIS (POOIDEAE: POEAE: AGROSTIDINAE), A NEW SPECIES FROM CALIFORNIA

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ABSTRACT

Agrostis lacuna-vernalis P.M. Peterson & Soreng, sp. nov., is described and illustrated. The new species occurs within or on the margins of vernal pools in Monterey County, California and is known only from the former Fort Ord Army Military Base. The new species is morphologically similar to *A. blasdalei* but differs by having an annual habit, shorter glumes (1.5–2.4 mm versus 1.8–4 mm), shorter lemmas (1.1–1.5 mm versus 1.5–3 mm), and longer paleas (0.4–0.7 mm versus ±0.3 mm).

RESUMEN

Se describe e illustra una nueva especie, **Agrostis lacuna-vernalis** P.M. Peterson & Soreng, sp. nov. La nueva especie ocurre dentro o en de los márgenes de piscinas vernales en el condado de Monterey, California y se sabe solamente del anterior la Fort Ord Army Military Base. La nueva especie es morfológicamente similar al *A. blasdalei* pero diferencia teniendo un hábito anual, los glumas más cortos (1.5–2.4 mm contra 1.8–4 mm), los lemas más cortos (1.1–1.5 mm contra 1.5–3 mm) y los paleas más largos (0.4–0.7 mm contra ±0.3 mm).

A small annual species of *Agrostis* L. had gone undetected on the former Fort Ord Army Military Base, now Fort Ord Public Lands (administered by the Department of Defense and the Department of the Interior, Bureau of Land Management) in Monterey County, California. Ellen Holmes, Nicolas Jensen, Randall Morgan, Dylan Neubauer, David Styer, and Vern Yadon initially collected this enigmatic grass but were unable to name it. Consequently, PMP and RJS were contacted for help, and based on their knowledge, it did not appear to be any previously described species of *Agrostis*. Since the new taxon is annual in habit, has narrow panicles, and has spikelets with awnless lemmas that are smooth and glabrous and relatively long paleas, there is nothing similar to it in the Flora of North America (Harvey 1993, 2007) and the second edition of the Jepson Manual (Peterson & Harvey in press). The possibility that the plant might be an introduction was considered, but it does not match any species from elsewhere in the world (Clayton et al. 2006). Earlier work on native coastal California *Agrostis* by Crampton (1967) recognized *A. clivicola* Crampton with two varieties, both now placed in synonymy of *A. densiflora* Vasey, and *A. blasdalei* var. *marinensis* Crampton, now placed in synonymy of *A. blasdalei* Hitchc. (Harvey 1993, 2007; Peterson & Harvey in press).

Agrostis is a member of the subtribe Agrostidinae and tribe Poeae in the subfamily Pooideae (Soreng et al. 2007). The Agrostidinae are distributed globally in temperate regions and tropical mountains, include 16 genera in some 550 species worldwide (Clayton & Renvoize 1986), and can be characterized by single-flowered

spikelets, glumes exceeding the lemma, lemmas with lateral veins extending to the apex, usually dorsal awns, hyaline paleas, membranous ligules, and caryopses with a punctiform hila and short embryos. The subtribe includes the diverse, ecologically important, and morphologically difficult genera: *Agrostis* (approximately 220 species), *Calamagrostis* Adans. (approximately 270 species), as well as other smaller genera (Saarela et al. 2010). In this paper we describe this unusual annual species as new to science.

Agrostis lacuna-vernalis P.M. Peterson & Soreng, sp. nov. (**Fig. 1**). TYPE: U.S.A. CALIFORNIA. Monterrey Co.: Fort Ord Army Military Base, Butterfly Valley, 2.8 km SSW of East Garrison and 9 km SW of Salinas, 36°37′ 56.2″N, 121°44′ 39.2″W, 140 m, 27 Apr–22 May 2010, *R. Morgan, D. Styer & D. Neubauer s.n.* (HOLOTYPE: US-3621794!).

Ab *Agrostis blasdalei* plantis annuis, glumis 1.5–2.4 mm longis, lemmatibus 1.1–1.5 mm longis, paleais 0.4–0.7 mm longis, recedit.

Loosely tufted annuals; major roots 0.1–0.3 mm diam.; culms (1.5–)5–30 cm tall, slender (ca. 0.25 mm diam.), erect to decumbent at the base, or slightly geniculate, smooth; internodes 2 or 3 per culm, nodes yellowish-brown, smooth, glabrous. Vegetative shoots intravaginal, prophylls (within 1–3 cm of the base), flattened and papery, 2 keeled, smooth except on the keels. Leaves mostly cauline and basal; sheaths ⅔ to ¾ as long as the internodes below, open to the base, margins broadly overlapping; ligules of upper leaves 1.2–1.7 mm long, hyaline, margins decurrent, abaxially lightly scabrous, apex acute to obtuse, erose, scabrous; blades 1.4–5(–11) mm long, 0.3–1(–1.5) mm wide, flat, folded to loosely involute on drying, thin and delicate, margins moderately minutely scaberulous, abaxially lightly scaberulous. Panicles 1–7.5 cm long, 1–6 mm wide, narrow, spicate, with 12–90(–110) spikelets, 1–3 branches per node; branches mostly 0.6–1.4 cm long, strict, appressed to suberect, capillary, moderately scabrous, hooks not in distinct lines; pedicels shorter or up to 2.5× longer than the spikelets, distally slightly expanded 0.2–0.3 mm just below the spikelet. Spikelets 1.5–2.4 mm long, 1-flowered; rachilla extension absent; glumes 1.5–2.4 mm long, longer than the floret, subequal (first slightly larger), ovate, herbaceous to scarious, greenish to distinctly purplish, 1-veined, laterally compressed, smooth to minutely muriculate below, scaberulous on the upper sides or only near the apex, more coarsely scaberulous along mid-vein from near the base, the minute hooks whitish under 10–50× magnification, apex mostly acute, scaberulous, margins lightly scabrous with slender hooks from near the middle to the apex; callus distinct, short, blunt, smooth, glabrous, disarticulation scar round; lemmas 1.1–1.5 mm long, subchartaceous, fragile, glossy, obscurely 5-veined, smooth, glabrous, clear to light green with a purplish blush near the vein tips and sometimes on the sides, unawned, keel vein extending to near the apex, the lateral veins faintly visible near the apex where there is commonly some purple coloration, margins broadly overlapping to within 0.15 mm of the base, smooth, apex obtuse to truncate, erose with age; paleas 0.7–1.1 mm long, about ½–⅔ as long as the lemma, scarious-hyaline, smooth, obscurely 2 veined, the veins closely spaced, the outer margin broader than the inter-keel gap, apex obtuse and minutely erose; stamens 3, anthers 0.4–0.7 mm long, yellowish; lodicules 2, 0.4–0.5 mm long, hyaline, slightly acentrically s-shaped, elliptic-lanceolate, entire, glabrous; ovary glabrous with two terminal adjacent styles and two stigmas. Caryopses 0.9–1.2 mm long, sub-adherent to the palea, ellipsoid, ventrally longitudinally distinctly grooved, dorsiventrally compressed, light greenish-brownish, translucent, embryo about ⅛ the length of the fruit, hilum indistinct, endosperm slightly malleable (lipid present).

Comments.—The new species can be distinguished from other species of *Agrostis* in North America by the following combination of characters: annual habit, narrow spicate panicles, spikelets with a glabrous callus, unawned lemmas that are smooth and subchartaceous, and anthers 0.4–0.7 mm long. The species is named after the habitat, vernal pool; "lacuna" for pool, and "vernalis" for spring or ephemeral.

Distribution and habitat.—*Agrostis lacuna-vernalis* is known from Mima mound area in Butterfly Valley (Fort Ord Army Military Base) and Machine Gun Flats (Fort Ord Public Lands) on the Monterey Peninsula between 115–145 meters elevation. It grows within or on the margins of vernal pools and is associated with (*= exotic/introduced): **Aira caryophyllea* L., *Allium hickmanii* Eastw., **Avena barbata* Link, **Briza minor* L., *Brodiaea terrestris* Kellogg ssp. *terestris*, **Bromus hordeaceus* L., *Calochortus uniflorus* Hook. & Arn., *Castilleja ambigua* ssp. *insallutata* (Jeps.) T.I. Chuang & Heckard, *Cicendia quadrangularis* (Lam.) Griseb., **Cotula coro-*

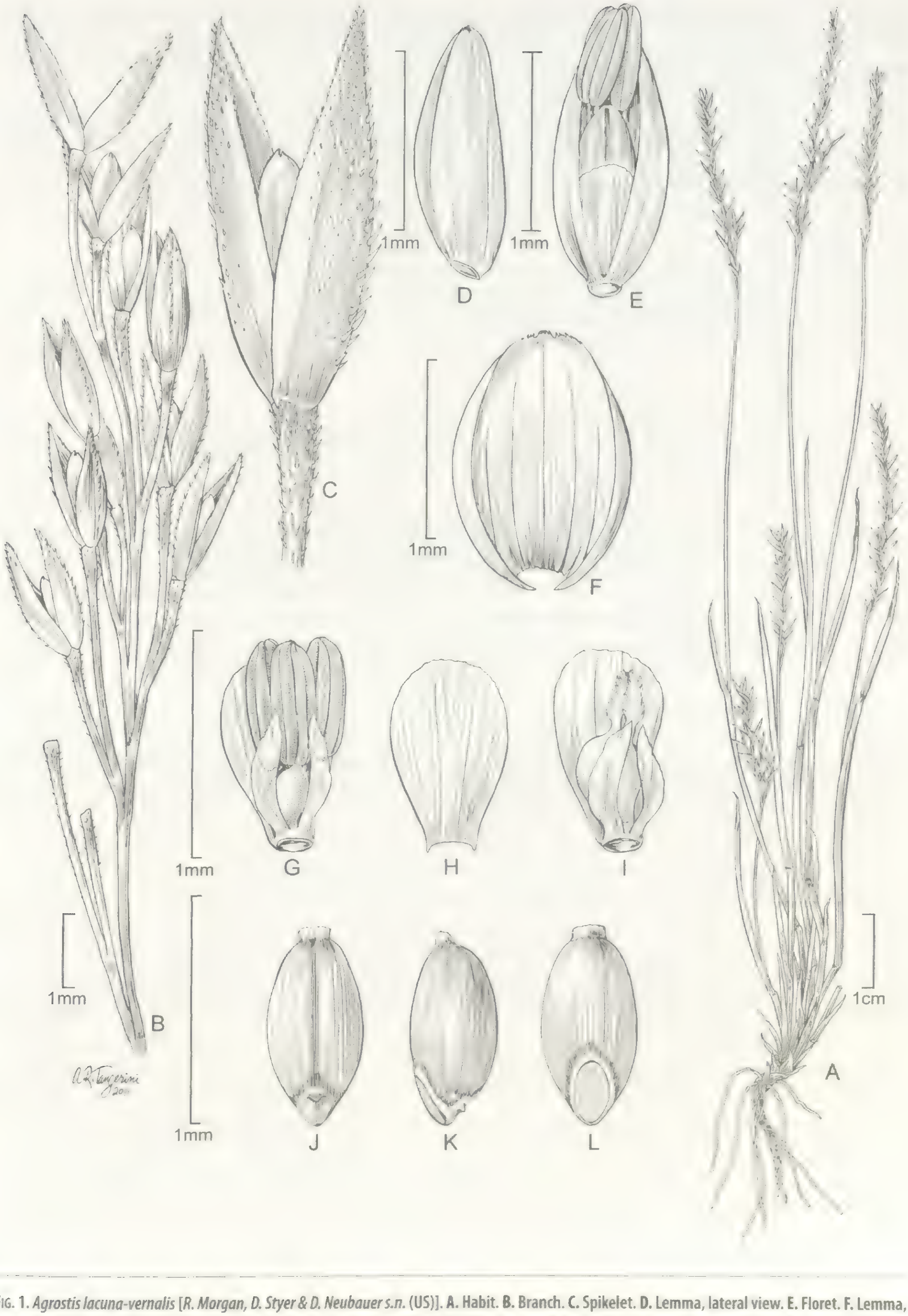

FIG. 1. *Agrostis lacuna-vernalis* [*R. Morgan, D. Styer & D. Neubauer s.n.* (US)]. A. Habit. B. Branch. C. Spikelet. D. Lemma, lateral view. E. Floret. F. Lemma, ventral view. G. Lodicules, stamens, pistil, and palea. H. Palea, dorsal view. I. Lodicules, pistil, and palea. J. Caryopsis, ventral view. K. Caryopsis, lateral view. L. Caryopsis, dorsal view.

nopifolia L., *Danthonia californica* Bol., *Deschampsia danthonioides* (Trin.) Benth., *Elatine brachysperma* A. Gray, *Eleocharis acicularis* (L.) Roem. & Schult., *Eryngium armatum* (S. Watson) J.M. Coult. & Rose, *Isoetes howellii* Engelm., *Juncus bufonius* (L.) var. *bufonius*, **J. capitatus* Weigel, *Lasthenia conjugens* Greene, *Leptosiphon parviflorum* Benth., *Lilaea scilloides* (Poir.) Hauman, **Lolium multiflorum* Lam., **Lythrum hyssopifolia* L., *Microseris paludosa* (Greene) J.T. Howell, *Montia fontana* L., *Plagiobothrys chorisianus* var. *hickmanii* (Greene) I.M. Johnst., *Pilularia americana* A. Braun, **Plantago coronopus* L., *P. elongata* Pursh, *P. erecta* E. Morris, *Psilocarphus chilensis* A. Gray, *Ranunculus californicus* Benth., *Sisyrinchium bellum* S. Watson, *Trifolium barbigerum* Torr., *T. buckwestiorum* Isely, *T. polyodon* Greene, *T. truncatum* (Greene) Greene, *T. variegatum* Nutt., and **Vulpia bromoides* (L.) Gray.

Additional specimens examined. **U.S.A. California. Monterey Co.:** Butterfly Valley, 24 May 2011, *D. Styer, C. Schneider, S. Hubbard, N. Wigington & K. Kasunich 1* (JEPS); *D. Styer, C. Schneider, S. Hubbard, N. Wigington & K. Kasunich 2* (CAS); *D. Styer, C. Schneider, S. Hubbard, N. Wigington & K. Kasunich 3* (US); *D. Styer, C. Schneider, S. Hubbard, N. Wigington & K. Kasunich 4* (RSA); Machine Gun Flats, 27 May 2011, *D. Styer s.n.* (JEPS, US).

DISCUSSION

The new species can be distinguished from other species of *Agrostis* in North America and California by possessing the following combination of characters: annual habit, narrow spicate panicles, spikelets with a glabrous callus, unawned lemmas, palea ½–⅔ the lemma, and anthers 0.4–0.7 mm long. *Agrostis lacuna-vernalis* is morphologically similar to three other California natives, *A. blasdalei, A. densiflora,* and *A. variabilis* Rydb. (Peterson & Harvey in press; Table 1). The new species differs from *A. blasdalei* by having an annual habit, shorter glumes (1.5–2.4 mm versus 1.8–4 mm), shorter lemmas (1.1–1.5 mm versus 1.5–3 mm), and longer paleas (0.4–0.7 mm versus ±0.3 mm). It differs from *A. densiflora* by having an annual habit, narrower blades [0.3–1 (–1.5) mm versus 2–10 mm], shorter lemmas (1.1–1.5 mm versus 1.5–2 mm), and a glabrous callus (versus minutely hairy). It differs from *A. variabilis* by having an annual habit, shorter lemmas (1.1–1.5 mm versus 1.5–2 mm), well-developed paleas (0.4–0.7 mm versus absent or minute), and a glabrous callus (versus minutely hairy). The new species also resembles *Agrostis muelleriana* Vickery from Australia and New Zealand but differs by having both cauline and basal leaf blades (mostly basal in *A. muelleriana*), narrower leaf blades [0.3–1(–1.5) mm versus 1–5 mm], shorter ligules (1.2–1.7 mm versus 2–3 mm), shorter glumes [1.5–2.4 mm versus (2–)2.2–3.5 mm), shorter lemmas 1.1–1.5 mm versus 1.3–2(–3) mm], and longer paleas (0.4–0.7 mm versus vestigial or absent) [Jacobs 2009].

Although we consider the new species to belong to *Agrostis* s.s., generic concepts in *Agrostis* s.l. have only been superficially examined by DNA studies (Soreng et al. 2007; Saarela et al. 2010), and their taxonomy can be controversial. The Poaceae editor for the Jepson Manual: Vascular Plants of California, ed. 2 (JMVPC2) treats in *Agrostis* one annual we prefer to treat as *Bromidium tandilense* (Kuntze) Rúgolo, and two perennials we prefer to classify as *Lachnagrostis filiformis* (G. Forst.) Trin. and *Podagrostis thurberiana* (Hitchc.) Hultén. The separation of these genera from *Agrostis* was/is accepted in the Catalogue of New World Grasses (Soreng et al. 2003, 2011) and was accepted for the Flora of North America (Barkworth et al. 2007). Under the imposed JMVPC2 generic concept there are now five annual species of *Agrostis* in California. Below we present a modified key to these annuals, adding the new species to the *Agrostis* treatment of Peterson & Harvey (in press) in JMVPC2.

The new species is globally rare. It is locally frequent, but only known from within a 2.5 km^2 area, and then only within wetlands in that area. There are estimated to be between 1000 and 10,000 individuals. Its maximum potential range is limited; similar, more or less intact Mima mound/vernal pool habitat covers less than 5 km^2 in the region (estimated from Google, DitigalGlobe aerial photo projection). Possible threats include competition from exotic grasses and other plants, and destruction of habitat from road building, off road vehicles, domestic livestock grazing, and adverse changes to the drainage patterns.

TABLE 1. Morphological and habitat comparison of *Agrostis lacuna-vernalis* to similar California grasses *A. blasdalei*, *A.densiflora*, and *A. variabilis*.

Species	*A. blasdalei*	*A. densiflora*	*A. variabilis*	*A. lacuna-vernalis*
Longevity	perennial	perennial	short-lived perennial	annual
Lemma length (mm)	1.5–3	1.5–2	1.5–2	1.1–1.5
Lemma awn (mm)	occasionally present, 4–7.5, geniculate	occasionally present, < 3.5, straight	generally absent	absent
Lemma texture & vestiture	scareous, easily torn or punctured, mat to sub-lustrous, smooth, nerves distinct	scareous, easily torn or punctured, mat to sub-lustrous, smooth, nerves distinct	scareous, easily torn or punctured, mat to sub-lustrous, smooth, nerves distinct	subchartaceous, glossy, smooth, easily fractured, nerves obscure
Palea length (mm)	ca. 0.3	0.5–0.7	absent or minute	0.7–1.1
Palea/Lemma ratio	< 1/3	± 1/3	n/a or <1/10	1/2–2/3
Anther length (mm)	1–2	± 0.5	0.5–0.7	0.4–0.7
Callus	glabrous	minutely hairy	minutely hairy on the margins	glabrous
Panicle density	dense	dense	fairly dense	fairly dense
Panicle exertion	base generally included in upper sheath	well exerted	well exerted	well exerted
Longest branches (cm)	< 0.5	< 0.5	0.5–1.5	0.6–1.4
Elevation (m)	< 100	< 200	1600–4000	115–145
Habitat	coastal bluffs, dunes, scrub, gravelly soils	coastal bluffs, cliffs, scrub, sandy soils	meadows, talus slopes, subalpine forests, and alpine	vernal pools around Mima mounds

KEY TO THE ANNUAL SPECIES OF "*AGROSTIS*" IN CALIFORNIA

1. Lemmas awnless ____ **A. lacuna-vernalis**
1. Lemmas awned from back or near the tip.
  2. Panicles open, generally oblong to ovate in outline; spikelets not crowded, panicle axes clearly visible ____ **A. elliottiana** Schult.
  2. Panicles dense, generally cylindrical; spikelets crowded, overlapping, panicle axes not clearly visible.
    3. Lemma teeth 4, two < 1 mm long, other two 1–1.5 mm; lemmas awned below middle; callus densely short-hairy ____ **A. tandilensis** (Kuntze) Parodi
    3. Lemma teeth 0 or 2, equal in length; lemmas awned at or above middle; callus generally sparsely hairy, hairs minute.
      4. Lemmas 2–4 mm long, awn 8–10 mm long ____ **A. hendersonii** Hitchc.
      4. Lemmas 1.5–2 mm long, awn 3.5–8 mm long ____ **A. microphylla** Steud.

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LOMATIUM PASTORALIS (APIACEAE), A NEW NARROW ENDEMIC SPECIES FROM NORTHEAST OREGON

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ABSTRACT

A new species, **Lomatium pastoralis,** is a tap-rooted, narrow endemic growing in shallow soils over basalt bedrock on the Umatilla and Wallowa-Whitman national forests in Umatilla County of northeastern Oregon, U.S.A. The species is most easily distinguished from other members of the genus by leaf morphology, inflorescence presentation, fruit shape, and pedicel length. The two presently recognized populations are confined to small areas over a several km^2 area. Populations can manifest as densely clustered plants in early seral settings wherein the species tends to be ecologically dominant, or as widely scattered plants in later seral stages. The species appears to require periodic disturbances in order to persist. Examination of annual root crown scars indicate that individuals may live in excess of 60 years. These data provide a critical element in the evaluation of population dynamics and informing conservation and management decisions and is apparently of significant conservation concern.

RESUMEN

Una nueva especie, **Lomatium pastoralis,** es una especie de raiz pivotante, endemica restringida descrita de suelos poco profundos desarrollados sobre basaltos en los Bosques Nacionales de la Umatilla y Wallowa-Whitman en el condado de Umatilla en el noreste de Oregon, U.S.A. Evidentemente tiene interés de conservacion. La especie se distingue facilmente de todos otros miembros del género y congéneres locales sobre todo por las caracteristicas morfológicas de la hoja, tipo de inflorescencia, forma del fruto y la longitud del pedicelo. Las dos poblaciones que se reconocen actualmente estan limitadas a pequeñas areas repartidas en unos pocos km2. Las poblaciones se pueden manifestar como grupos de plantas densamente agrupadas en etapas seriales tempranas en las que la especie tiende a ser ecológicamente dominante, o como plantas dispersas en las últimas etapas seriales. La especie parece requerir alteraciones periodicas para persistir en el paisaje. El examen anual de las cicatrices de la corona de la raíz indican que los individuos pueden vivir mas de 60 años. Estos datos proporcionan un elemento critico en la evaluación de la dinamica de la poblacion e informan de la conservacion y de las decisiones sobre su gestión.

INTRODUCTION

Collections were made by David Wagner of an unrecognized *Lomatium* species in June 1978, from shallow lithosol soils at 1555 m on a gentle south-facing slope on the north side of Green Mountain in Umatilla County, Oregon on the Umatilla national forest. Subsequent examination of specimens by Lincoln Constance at the Jepson Herbarium, University of California at Berkeley, confirmed the material to be an undescribed entity. It was provisionally named *Lomatium pastoralis* by Wagner recalling the prior history of the general area as an important domestic sheep pasturing summer range. In the intervening years this species has been purportedly recognized at several other nearby sites, but these locales remain to be revisited and confirmed regarding their present status. Reports of *Lomatium pastoralis* from other nearby localities have either not been successfully relocated, are presently unconfirmed, or have been recently discounted under further scrutiny.

Initial thoughts that the species was most probably not of immediate conservation concern owing to the robust nature of the type locality population and its apparent ability to proliferate in artificially disturbed sites contributed to a delayed publication schedule. Numerous subsequent botanical survey results of the general area by several experienced field botanists on both the Umatilla and Wallowa-Whitman national forests over the last three decades now argues strongly that the species is indeed both rare and in significant need of management as a conservation interest.

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Lomatium is the largest genus of the Apiaceae in North America and it continues to be one of the most noteworthy contributors to the ever-increasing knowledge of vascular plant diversity in North America north of Mexico. Several new species have been described over the last quarter century including *L. cookii* (Kagan 1986), *L. shevockii* (Hartman and Constance 1988), *L. ochocense* (Helliwell 2010), *L. tamanitchii* (Darrach et al. 2010), and *L. bentonitum* (Carlson et al. 2011). In addition, several other confirmed but as yet unpublished *Lomatium* taxa make recent additions to our knowledge of western North America floristics particularly salient (P. Brunsfeld pers. comm.; Darrach in prep; Giblin pers. comm.).

It is also of significance that nearly all of the recently described species in *Lomatium* are of conservation concern (NatureServe Explorer 2010). Overall, of the 102 presently recognized taxa comprising the genus, in excess of 40% are rare or present in abundance only over very narrow ranges. The large number of rare species places *Lomatium* on a par with similar levels of rarity in two other noteworthy, diverse, and largely western North American genera: *Eriogonum* (Polygonaceae) and *Penstemon* (Plantaginaceae) (NatureServe Explorer 2010). The additional importance of *Lomatium* as a critical source of First Foods for native peoples, and for herbal and potential phamaceutical uses (Lee and Soine 1968; Nielson and Jensen 1975; Hunn and French 1981; Chou et al. 2006) points toward a particularly critical need to acquire further understanding of taxonomic relationships and the ecologic requirements and population parameters of this important genus of plants.

TAXONOMY

Lomatium pastoralis D.H.Wagner ex M.E. Darrach & D.H. Wagner, sp. nov. (**Fig. 1**). TYPE: U.S.A. OREGON. Umatilla Co.: N side of Green Mountain, ca. 10 mi NNE of La Grande, T1S R37E Sec. 10. Lat. 45°29'16"N; Long. 118°9'42"W, elev. 1555 m (5100 ft), very abundant in vernally wet open lithosol habitat on south facing portion of ridge top, 23 Jun 1978, *D.H. Wagner 2137* (HOLOTYPE: OSC; ISOTYPES: UC, WTU).

Lomatium pastoralis plantae glabrae acaulescentes e radice elongatae; folia oblonga vel ovata 1–3 ternata, foliis linearibus vel lineari-lanceolatis; radii fertiles inaequales; involucellae bracteolae incospicuae scariosae lineares vel lineari-lanceolatae; flores luteolus; fructus glaber ovalis vel oblongo-ovalis, alis quam corpore multo angustioribus; vittae minimae in intervallis plures.

Herbs perennial, long-lived, weakly aromatic, glabrous, acaulescent, 0.6–3.7 dm. Taproot simple, terete, rarely somewhat tuberous or flattened when growing in narrow rock fractures, 4.0–18.0 cm long, 1.0–15.0 mm wide, surmounted by a simple root crown and a narrow terete subterranean pseudoscape 21.0–78.0 mm long. Old, leaf bases usually present, appressed to the pseudoscape, 1.0–41.0 mm long, entirely beneath the ground surface in all cases. **Leaves** 2–11 (typically 3), glabrous, compound ternate-pinnate, usually partially bipinnate, 4.5–17.9 cm wide, 5.6–15.2 cm long. Petioles 1.1–8.5 cm long with variably developed winged basal portions, winged bases herbaceous, green to light violet-red when young, becoming tawny-chartaceous with age, with 3–15 prominent nerves. Reduced, often once pinnate axillary leaves usually present, petioles enclosed within broad-winged bases of larger primary leaves, wings lacking or minimally developed, often lacking nerves. Pressed leaves usually ca. 15% broader than wide, the leaf outline equilaterally triangular to quadrate, rhombic; axillary leaves narrowly rhombic. Leaflets spreading to weakly overlapping, entire, narrowly elliptical, narrowly oblanceolate, spatulate or linear-filiform, ultimate segments 1–60 mm long, 0.8–9.7 mm wide, occasionally bearing an obscure, minute, non-photosynthetic apiculus. Inner axillary leaves usually have both the longest and most delicate narrow ultimate leaflet segments. Leaves with the most strongly developed petiole wings tend to have the shortest ultimate leaflet segments. Peduncles terete, with minute longitudinal corrugations that are noticeably rough to the touch, often anthocyanic, 6.3–32.3 cm long when mature, basal portion usually strongly decumbent, distal portion curving to sigmoidal, moderately to steeply ascending, greatly exceeding the leaves as the fruits mature. **Inflorescences** compound, involucre none, up to 10 per plant (typically 2 or 3); shorter, axillary peduncles often present. Rays 3–22, unequal in length in flower, becoming markedly so as the fruit matures, dimidiate, usually spreading less than 180°. In flower the shortest rays 1.0–4.0 mm, longest rays 2.3–63 mm, longer rays bearing umbellets with mostly perfect flowers but often a few scattered male flowers present, shorter rays usually bearing predominantly or entirely male flowers. Shortest rays 1.0–22 mm on fruiting inflorescences, longest rays 12.6–106.0 mm on fruiting inflorescences. **Involucel**

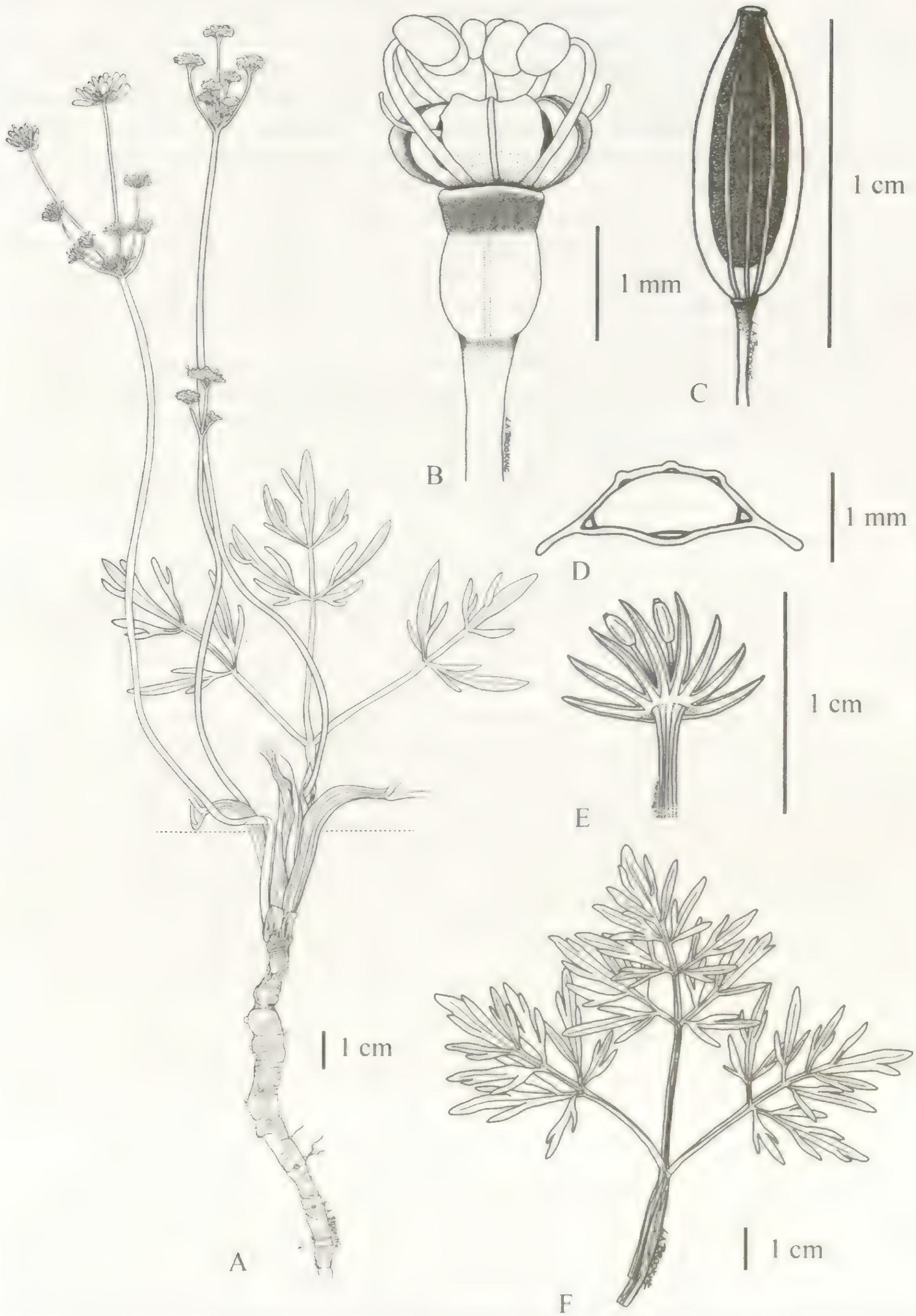

FIG. 1. *Lomatium pastoralis* D.H.Wagner ex M.E. Darrach & D.H. Wagner. A. Habit with dashed line representing typical location of ground surface; B. perfect flower at anthesis; C. mature fruit; D. mature fruit transection depicting vittae; E. involucel; F. typical leaf morphology. Specimen drawn from Mark Darrach collection #429 15 Jun 2009 T1S R37E NW$^{1/4}$SE$^{1/4}$SE$^{1/4}$ Sec.10 Umatilla Co. Oregon.

bracts 1–12 (typically 4–8), 1.6–5.0 mm long, 0.1–1.3 mm wide, glabrous, free to the base, herbaceous, usually with a prominent mid-vein, often somewhat anthocyanic with very narrow scarious margins, typically strongly dimidiate, rarely wanting, variously shaped but always narrow, from narrowly oblanceolate to narrowly lanceolate, narrowly obovate, weakly spatulate, narrowly elliptic, or linear. Short, staminate umbellets frequently somewhat contorted and clustered at the umbel center, irregularly deciduous by maturity. Male flower pedicels 0.9–2.7 mm long, consistently longer on average than perfect flower pedicels; perfect flower pedicels 0.3–1.2 mm. **Flowers** glabrous, 5–29 per umbellet; petals bright yellow to rarely cream, 1.2–1.6 mm long, 0.4–0.9 mm wide, with a clear to greenish midvein, ovate to broadly ovate, with an adaxially strongly incurved, 0.2–0.3 mm apiculus; anthers bright yellow to creamy yellow, 0.3 mm long, 0.25 mm wide; stylopodia green, styles incurved, 1.2 mm to 1.8 mm long, 0.2 mm wide. **Fruit** 0–21 per umbellet, the longer rays usually bearing more fruits, fruits hemispherically arranged on the umbellets, pedicels ascending-spreading to erect, 0.1–5.4 mm (typically 2.5–3.5 mm) long. Fruits glabrous, 5.3–11.4 mm long, 2.2–3.8 mm wide, body portion 1.5 mm to 2.7 mm thick, wing 0.15–0.60 mm, not obviously thickened, strongly dorsiventrally compressed, base rounded, tips acute to weakly acuminate, often weakly falcate and elliptical, narrowly elliptical to ovate and oblong, color alternating tawny and dark gray (5Y4/3) and very dark gray (2.5Y3/1) intervals (Munsell, 2000). Dorsal surface of the fruits have 3(2–4) strongly developed nerves not elevated above the fruit surface; vittae obscure, 3–5 (typically 3) in the intervals, 1–3 (typically 1) along the commisure, 1 in each of the proximal portions of the wings. Carpophore cleft to base, persistent.

Measurements presented here are derived from a combination of dried and pressed herbarium material and material evaluated from specimens fresh from, and in, the field. *Lomatium pastoralis* emerges in late April to early May, or as prevalent snowpack may allow. Flowers are at or near anthesis in late May and very early June, with fully mature fruit present by late June. Plants rapidly become fully senescent shortly thereafter. Accurate on-the-ground evaluation of the presence of *Lomatium pastoralis* is very difficult after mid-July in most years.

Habitat.—*Lomatium pastoralis* is generally found on gently sloping, vernally moist to occasionally saturated "scabland" lithosol settings that are fully dessicated later in the season. These sites typically have a shallow crust of silty fines, eroded from adjacent deeper soils, over highly-fractured lava flow entablatures of the regionally extensive Miocene age Columbia River Basalt Group. The species can also be found in extremely disturbed sites, such as the fractured basalt bedrock on the excavation floor of an inactive crushed rock quarry.

Range.—The species is known historically from a few localities near the type population as presented in the "paratypes" section. These populations, should they still exist, have yet to be rediscovered and evaluated. Their status and size/vitality is unknown. This paper recognizes the confirmation of only two populations, both from Umatilla County, northeast Oregon. Individuals comprising the type population number perhaps 10,000, with a recently discovered second population restricted to approximately 750 individuals. Recruitment at the type locality is strong.

Associated vascular plant taxa known to co-occur with *Lomatium pastoralis* include: *Achillea millefolium, Achnatherum lemmonii, Allium fibrillum, Antennaria luzuloides, Balsamorhiza hookeri var. hirsuta, Bromus marginatus, B. tectorum, Camassia quamash, Cistanthe umbellata, Collinsia parviflora, Collomia linearis, Danthonia unispicata, Delphinium nuttallianum, Dodecatheon conjugens, Draba verna, Epilobium brachycarpum, Eriogonum heracleoides, Floerkia proserpinacoides, Fritillaria pudica, Hesperochiron pumilis, Juncus parryi, Lewisia nevadensis, Linanthus harknesii, Lithophragma parviflora, Lomatium ambiguum, L. leptocarpum, L. grayi, L. piperi, Lupinus aridus var. aridus, Lupinus sulphureus, Madia glomerata, Montia linearis, Navarretia intertexta, Olsynium douglasii var. inflatum, Paeonia brownii, Phlox austromontana, Phlox gracilis, Plagiobothrys scouleri var. penicillatus, Poa secunda, Polygonum douglasii var. majus, Polygonum kelloggii, Pseudoroegneria spicata, Pyrrocoma carthamoides, Sanguisorba occidentalis, Sanicula graveolens, Saxifraga nidifica, Sedum stenopetalum, Senecio integerrimus var. exaltatus, Sidalcea oregana var. procera, Triteleia grandiflora var. grandiflora*, and *Vulpia bromoides*.

Lomatium pastoralis is distinct and most readily identified in the field relative to its immediately associated and nearby congeners by the following characters: narrowly elliptical fruits on short, but easily-observed

pedicels, a usually strongly dimidiate involucel, relatively broad simple leaflets, and peduncles that remain very strongly decumbent proximally through to full maturity with weakly-to-moderately ascending and often sigmoidal middle and distal segments. A composite illustration of the species is provided in Figure 1.

The species with which *Lomatium pastoralis* is most likely to be confused are *L. leptocarpum* and *L. ambiguum*. *Lomatium leptocarpum* is an occasional to frequent associate. It differs in having nearly sessile, narrowly oblong fruits, a usually well-developed radial involucel, narrow and more numerous leaflets, and peduncles which are only rarely strongly decumbent at the base. *Lomatium ambiguum* is infrequently found scattered within the known *L. pastoralis* populations but it is more abundant on directly adjacent scabland lithosol sites with better drainage and similar gentle, but somewhat steeper slopes. *Lomatium ambiguum* has long pedicels with upright fruits, lacks an involucel entirely, typically includes at least one cauline leaf on mature specimens, and does not possess decumbent peduncle bases. A full key to possible nearby congeners is presented below.

Paratypes. **U.S.A. OREGON. Umatilla Co.:** type locality, 23 Jun 1978, *Wagner 2138* (OSC); 4 Jun 1979, *Wagner 2303* (OSC, UC); 5 Jul 1980 *Wagner 2516* (OSC); 12 Jun 1991, *Wagner 4521* (OSC); 6 Jul 2002, *S. Markow 12354*, 6 Jun 2003, *S. Markow 12467* (OSC, RM); 20 Jun 2003, *S. Markow 12481* (OSC); Ruckel Ridge near Big Saddle, ca. 15 mi N of La Grande, T1N R37E Sec. 13, 1,280 m (4,200 ft); 5 Jul 1980, *Wagner 2522* (OSC); Ruckel Ridge Road near junction of Thimbleberry Mt. Road, ca. 13 mi N of La Grande, T1N R37E Sec. 25, 1,400 m (4,600 ft); 5 Jul 1980, *Wagner 2530* (OSC); Green Mt. area, 15 mi N of La Grande, in a rock pit near Forest Service Rd 3116, Umatilla National Forest, T1S R37E Sec. 10 SE$^{1/4}$ of SE $^{1/4}$, 3 Jul 1991, *Paula Brooks* s.n. (OSC); *Wagner 4521* (OSC); head of Smith Canyon, ca. 13 air mi NE of Meacham, T1N R37E Sec. 24 SE, 5,600 ft, 28 Jun 2003, *S. Markow 12493* (OSC, RM); W side Mount Emily Road, 100 yards W of and overlooking Pot Creek, ca. 14 air mi E of Meacham, T1S R37E Sec. 6 SW$^{1/4}$NW$^{1/4}$, *S. Markow 12468* (OSC, RM); meadow 100 yards W side Mount Emily Road, 100 yards N of and overlooking Pot Creek, ca. 15 air mi NE of Meacham, T1S R37E Sec. 25 NW$^{1/4}$NW$^{1/4}$, 5,600 ft, 6 Jun 2003, *S. Markow 12471* (OSC, RM); Nine Mile Ridge ca. 30 ft E of Forest Service Road 287 at intersection with Forest Service Road 31 (Summit Road), ca. 6 air mi S of Tollgate, T3N R38E Sec. 32 NW$^{1/4}$SE$^{1/4}$, 5,200 ft, 20 Jun 2003, *S. Markow 12484* (OSC, RM); E side Mount Emily Road, overlooking Fir Creek, ca. 15 air mi NE of Meacham, T1S R37E Sec. 36 NE$^{1/4}$NE$^{1/4}$, 5,600 ft, 6 Jun 2003, *S. Markow 12468* (OSC,RM).

KEY TO POSSIBLE *LOMATIUM* CONGENERS WITH *LOMATIUM PASTORALIS*

1. Plants with obvious simple tuberous thickened root; rarely, if ever, moniliform.
   2. Plants with partially fused ovate to obovate involucel bracts; flowers yellow ________ **L. cous** (S. Wats.) J.M Coult & Rose
   2. Plants with narrow to linear involucel bracts free to the base; flowers white.
      3. Plants lacking reduced cauline bract; mature fruit scabrous ________ **L. gormanii** (Howell) J.M Coult. & Rose
      3. Plants with a single reduced cauline bract; mature fruit glabrous________ **L. piperi** J.M Coult. & Rose
1. Plants lacking or very rarely displaying simple tuberous thickened root, but may have distinctly moniliform root thickenings.
   4. Flowers white; involucel bracts distinctly ciliate-short hairy ________ **L. macrocarpum** (Nutt. ex Torr. & A. Gray) J.M. Coult. & Rose
   4. Flowers yellow, pale yellow or, occasionaly, red-purple; involucel bracts glabrous.
      5. Large majority of ultimate leaf segments 10 mm in length or less.
         6. Plants robust; 5–15(–20) dm at maturity; umbels and fruit large (to 17 mm in length); in this region plants often on steep, rocky, partially shaded slopes or soil pockets on cliffs ________**L. dissectum var. multifidum** (Nutt.) Mathias & Constance
         6. Plants not robust; <5 dm at maturity; umbels and fruit smaller (<17mm in length); plants typically on more gentle terrain, and in full sun.
            7. Mature fruit with length/width ratio typically 6:1 but ranging from 3.3:1 to 13.3:1; mature fruit pedicels very short (0.9–)1.2–2.0(–2.7) mm; ultimate leaf segments few________ **L. leptocarpum** Torr. & A. Gray
            7. Mature fruit with length/width ratio 3:1 or less; mature fruit pedicels at least 4mm; ultimate leaf segments very numerous.
               8. Ultimate leaf segments numerous and mostly in same plane; 1.5–8.0 mm, usually overlapping and strongly bluish-glaucous; root crown simple and largely lacking old leaf bases; plant odorous, but not strongly so ________ **L. donnellii** (J.M Coult. & Rose) J.M Coult. & Rose
               8. Ultimate leaf segments up to 6 mm, very numerous, and non-planar; rarely clearly glaucous; root crown with a branching caudex that retains old leaf bases; strongly, pungently odorous when crushed ________**L. grayi** (J.M Coult. & Rose) J.M Coult. & Rose
      5. Large majority of ultimate leaf segments greater than 10 mm in length.
         9. Involucel absent.
            10. Leaflets prominently veiny; 1–4 cm broad; usually toothed at terminus; leaves basally disposed; inflorescences with swelling at base of umbel ________ **L. nudicaule** (Pursh) J.M Coult. & Rose
            10. Leaflets not prominently veiny; segments narrow (0.7–)1.0–4.0(–5.0) mm broad; at least one cauline leaf on most specimens; inflorescences lacking swelling at base ________ **L. ambiguum** (Nutt.) J.M Coult. & Rose
         9. Involucel present; very rarely absent.

11. Peduncles usually strongly ascending at maturity; and lacking clearly decumbent bases.
  12. Mature fruit narrow, nearly linear, with length-width ratio typically 6:1 but ranging from 3.3:1 to 13.3:1; mature fruit pedicels short (0.9–)1.2–2.0(–2.7) mm ____ **L. leptocarpum** Torr. & A. Gray
  12. Mature fruit narrowly elliptical to oblong, length-width ratio 3.5:1 or less; pedicels 2-10 mm.
    13. Mature fruits lacking broad wings ____ **L. triternatum var. triternatum** (Pursh) J.M. Coult. & Rose
    13. Mature fruit with prominent wings nearly or quite as wide as body ____ **L. simplex var. simplex** (Nutt.) J.F. Macbr.
11. Peduncles usually weakly ascending at maturity with strongly decumbent bases ____ **L. pastoralis** D.H. Wagner ex M.E. Darrach & D.H. Wagner

CONSERVATION, ECOLOGY, AND PHENOLOGY

Lomatium pastoralis typically emerges in late April or early May, but may emerge earlier in low snowpack years. Flowering progresses through mid-May to anthesis around the last week of May through the first week of June. Mature fruit are present and dehiscent by the end of June and the plants are quickly senescent and largely reduced to remnant material around the root crown by mid-July.

Lomatium pastoralis is known to grow exclusively on shallow, poorly-developed soils over Miocene age Columbia River Basalt bedrock in open, vernally moist, "scabland" lithosol settings. These soils typically display a thin veneer of silty, non-plastic fines with very little exposed rock. However, an abundant, highly fractured basalt layer is present at very shallow depths, well within the rooting zone of the plants.

The species typically occurs as very dense populations in which it is generally either a dominant or co-dominant species. Observations of the documented populations strongly argue that the species is an early seral occupant of disturbed landscapes. One segment of what is presumed, in lieu of a more formal census and search effort, to be the largest population of the species now occupies the floor of a road metal basalt quarry that has been inactive for approximately 20-years (Anderson pers. comm.). In this setting the species forms a near monoculture, locally achieving 100 percent cover or in co-dominance with *Camassia quamash* and *Floerkia proserpinacoides*. In contrast, a recently discovered population in a later seral ecological setting on the southeast slopes of Green Mountain numbers approximately 750 widely-scattered individuals as other species have established and proliferated in vegetative succession; particularly *Lupinus aridus* var. *aridus*.

The area where *Lomatium pastoralis* is found has a history of intensive domestic sheep grazing by large flocks numbering in the many thousands. In the wake of these destructive land usage policies, most notably in the early part of the 20th century, unforested shallow soil habitats were left largely devoid of a native grass component. The type locality is immediately adjacent to a water source, so that flocks of sheep were frequently kept overnight in this meadow (C. Johnson pers. comm.). These areas were nearly completely denuded at times and left in a vegetative disclimax condition that persists to the present (Darrach pers. obs.; Langford 1996). It is surmised that disturbance of this magnitude may well have provided ideal conditions for proliferation of the species as an early seral strategist reliant upon a persistent disturbance regime. In addition, some unpalatable *Lomatium* taxa are known to increase in biomass under grazing pressure (Lathrop pers. comm.; Utah State University 2011; Johnson unpublished data). Another possible allied factor includes allelopathic interactions. A number of *Lomatium* taxa are quite pungent and have secondary chemicals that make them likely candidates for possessing inhibiting allelopathic qualities (Asuming et al. 2004; Meepagala et al. 2006).

An affinity to occupy sites with an ecological approach dependent upon some form of persistent landscape disturbance can be a precarious evolutionary strategy that may inherently lead to rarity upon the landscape (Parsons & Brown 1982; Hardin & White 1989; Lesica & Cooper 1999). This is particularly so if the source(s) of disturbance are not consistent over the long term (Parsons & Brown 1982). Conversely, reliance upon disturbance as an ecological strategy can provide long-term viability if primary disturbance factors such as the inherent instability of a geologic substrate—for example talus slopes and shrink-swell clay substrates—is the primary source of disturbance (Parsons & Brown 1982; Mastroguiseppe et al. 1985; Darrach & Thie 2010). As discussed above regarding observations by the authors, *Lomatium pastoralis* appears to have a strong affinity for disturbed locales and is most probably adapted as an early seral species.

As domestic sheep grazing has become much more tightly regulated, and indeed permit grazing of both

sheep and cattle in the general area of the known *Lomatium pastoralis* populations has been greatly curtailed relative to historic levels (Lathrop pers. comm.), a significant source of disturbance that may have allowed for the persistence of the species upon the landscape has been reduced. However, an additional important source of persistent disturbance at the type locality at the present time is provided by a robust population of the fossorial northern pocket gopher—*Thomomys talpoides*. As long as this rodent population persists at the site, the bioturbation activites of these small mammals would appear to create an ideal disturbance vehicle in turn supporting a continuing healthy population of *Lomatium pastoralis*. Other possible sources of persistent ground disturbance in the area include periodic fire control activities, the presence of herds of big game, unauthorized off-road vehicle usage, sheet runoff during snowmelt and extreme precipitation events, and soil surface movements associated with freeze-thaw cycles under saturated conditions. Freeze-thaw cycles are most probably a minor contributor as the clay content of soil fines is low and winter soil temperature fluctuations are likely moderated by the insulating effects of significant snow cover in most years.

The possibility that the historical vegetation character of these open scabland sites was sufficiently robust to carry low intensity fire is also of interest. Fire is a disturbance that often plays a fundamental role in plant community and plant population dynamics (Bond & van Wilgen 1996). Fire suppression activities over the last 100-years have greatly altered fire return intervals and indeed the absence of fire is implicated as the principal threat to approximately 4% of the endangered flora in the United States (Schemske et al. 1994). While little research has specifically centered upon the role of fire as a contributing factor to population dynamics in the genus *Lomatium*, the work of Kaye and others (2001) is a notable exception. Their stochastic transition matrix modeling efforts as applied to a series of experimental fire treatments on populations of the federally endangered species *Lomatium bradshawii* in the Willamette Valley of Oregon clearly illustrates the critical role fire plays to this disturbance-dependent species. It seems likely that the damage inflicted to soils by historical long-term intensive grazing on the sites presently occupied by *Lomatium pastoralis* may have reduced the capacity of these locales to support sufficient biomass to carry fire. In this regard, the near absence of a native perennial bunchgrasss (e.g. *Poa secunda* and *Pseudoroegneria spicata*) component in particular is noteworthy.

Conservation management concerns regarding *Lomatium pastoralis* center around the likelihood of the plant as being dispersal-limited (Thompson 1985; Marsico & Hellmann 2009), having short seed bank residence time with questionable year-over-year viability (Thompson 1985; Kaye et al. 2001), and as an early seral specialist reliant on a possibly unstable disturbance regime for long-term persistence upon the landscape. Judicious use of periodic surface scarification in the area of existing populations is suggested for consideration as a management tool—particularly as later seral vegetative stages begin to take hold. In addition, the possible use of low intensity fire, perhaps with minor fuels enhancement may be of management value. While in-situ seed predation is noted from entrance holes in endosperm material on a few mature fruits, and rodent activity observed in the field (Wagner pers. obs.) while conducting the morphometric analysis, the impact of seed predation upon recruitment remains to be more fully evaluated.

Inspection of root morphology reveals that individuals of *Lomatium pastoralis* typically display well-developed root crown scars. These root crown scars, which clearly appear to be correlated with plant age, have been observed to be 13–61 in number in a sample of 76 specimens (Darrach unpublished data). These data provide an important temporal element to understanding the population dynamics of the species. While some plants may indeed live to be much older, or, conversely, the 61-year-old specimen may be an outlier in a species that rarely achieves such longevity, this information provides some guidance that can inform conservation management decisions.

We note that the genus *Lomatium* as a whole, and indeed perhaps a much broader suite of perennial herbaceous plants that die back to the root crown each season, deserves attention regarding this readily observed, but previously overlooked source of information. While some species may prove difficult to evaluate for longevity owing to morphologies that preclude accurate analysis—for example persistent strongly sheathing leaf bases that obscure the root crown and caudices—the large number of rare species in this genus indicate that the effectiveness of conservation biology efforts may benefit considerably from a study of plant longevity. In

addition, the emerging climatology sub-field of shrub and herb chronology (for example Rayback & Henry 2006; Rozema et al. 2009; Franklin pers. comm.) may find value in this information.

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BOOK REVIEW

Carl Friedrich Philipp von Martius and text by H. Walter Lack. 2009. **The Book of Palms.** (ISBN 978-3-8365-1779-9, hbk.). Taschen GmbH, Hohenzollernring 53, D-50672 Köln, Germany. (**Orders:** www.taschen.com, contact@taschen.com, +49-221-20-18-00). $150.00, 412 pp., color illustrations, line illustrations, 12½" x 17½".

When I picked up the book to begin reviewing it I was amazed not just because of its size and weight, but also because of the quality of the production and illustrations. This large format book, over a foot by a foot and a half, is a reproduction of Carl Friedrich Philipp von Mauritius's magnificent 19th century botanical study of palm trees; *Historia naturalis palmarum: opus tripartitum* (Natural History of Palms: a work in three volumes), published between 1823–1853. This book was the first modern classification of palms, including the first maps of palm biogeography and which described all the palms of Brazil, and collated the sum of all then-current knowledge of the palm family. TASCHEN has reproduced this book and Mauritius's incredibly illustrated plates from a copy of his original work. The text was authored by H. Walter Lack.

"On 15 December 1868, Carl Friedrich Philipp von Martius (1794–1868), Professor of Botany at the University of Munich and director of the Royal Botanic Garden, was carried to his grave in a coffin covered with fresh palm leaves. These were a reference to his groundbreaking *Historia naturalis palmarum: opus tripartitum*. At the time, this encyclopedic treasury contained the sum of human knowledge on the topic, and included 240 exquisite chromolithographic illustrations, including landscape views of palm habitats and botanical dissections. This epic folio was based on Mauritius's expedition to Brazil and Peru with zoologist Johann Baptist von Spix, sponsored by King Maximilian I of Bavaria, to investigate natural history and tribal Indians. From 1817 to 1820 the pair travelled over 2,250 km (1,400 miles) throughout the Amazon Basin, the most species-rich palm region in the world, collecting and sketching specimens. On their return both men were awarded knighthoods and lifetime pensions.

In his epic work, Martius outlined the modern classification of palm, produced the first maps of palm biogeography, described all the palms of Brazil, and collated the sum of all known genera of the palm family. For apart from his own collection of specimens and notes, Martius also wrote about the findings of others. Mauritius's folio is unusual in its inclusion of cross-sectioned diagrams, conveying the architecture of these mighty trees, which central Europeans would have found hard to imagine accurately. Equally remarkable are the color landscapes showing various palms – often standing alone – which have a simple and elegant beauty. This famous work is an unrivaled landmark in botanic illustration and taxonomy."

The history of the book is interesting in itself but you need to see the illustrations to appreciate the full scope of this publication. Three of the illustrations fold out to nearly four times the dimensions of the book itself—24 x 33 ½ in. They are simply awesome in their size and detail. And did I mention intensity of the color? This is a publishing event and a labor of love from TASCHEN. I applaud their dedication to the size and scope of the original and the decisions they made during the production of this magnificent volume.

Prof. Dr. H. Walter Lack is Director at the Botanic Garden and Botanical Museum Berlin-Dahlem and Professor at the Free University of Berlin. A leading expert in the history of botany, his research interests focus in particular upon the consequences of the global transfer of useful and ornamental plants from the point of view of our cultural history. He has also authored *The Flora Graeca Story*, Oxford 1998, *A Garden of Eternity*, Berne 2000, *Garden Eden*, Koln 2001 and most recently *Florilegium Imperiale*, Munich 2006.—*Gary Jennings, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

NEW COMBINATIONS, RANK CHANGES, AND NOMENCLATURAL AND TAXONOMIC COMMENTS IN THE VASCULAR FLORA OF THE SOUTHEASTERN UNITED STATES

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ABSTRACT

We make generic transfers and rank changes of taxa distributed primarily in the southeastern United States. These include transfers from *Prenanthes* to *Nabalus* (Asteraceae or Compositae), from *Senecio* to *Packera* (Asteraceae or Compositae), from *Onosmodium* to *Lithospermum* (Boraginaceae), from *Trichomanes* to *Crepidomanes* (Hymenophyllaceae), from *Osmanthus* to *Cartrema* (Oleaceae), from *Thelypteris* to *Stegnogramma* (Thelypteridaceae), from *Panicum* to *Coleataenia* (Poaceae or Gramineae), from *Panicum* to *Dichanthelium* (Poaceae or Gramineae), and from *Vitis* to *Muscadinia* (Vitaceae), as well as making rank changes involving taxa in *Viburnum* (Adoxaceae), *Hypericum* (Hypericaceae), *Spigelia* (Loganiaceae), *Andropogon* (Poaceae or Gramineae), and *Leptochloa* (Poaceae or Gramineae). New names are proposed in *Coreopsis* (Asteraceae or Compositae) and *Lithospermum* (Boraginaceae). We additionally discuss the taxonomy and appropriate rank of additional taxa not requiring new combinations in many of these genera, based on recent herbarium and field studies.

RESUMEN

Hacemos transferencias genéricas y cambios de rango de taxa distribuidos primariamente en el suroeste de los Estados Unidos. Esto incluye transferencias de *Prenanthes* a *Nabalus* (Asteraceae o Compositae), de *Senecio* a *Packera* (Asteraceae o Compositae), de *Onosmodium* a *Lithospermum* (Boraginaceae), de *Trichomanes* a *Crepidomanes* (Hymenophyllaceae), de *Osmanthus* a *Cartrema* (Oleaceae), de *Thelypteris* a *Stegnogramma* (Thelypteridaceae), de *Panicum* a *Coleataenia* (Poaceae o Gramineae), de *Panicum* a *Dichanthelium* (Poaceae o Gramineae), y de *Vitis* a *Muscadinia* (Vitaceae), así como hacer cambios de rango que implican a taxa de *Viburnum* (Adoxaceae), *Hypericum* (Hypericaceae), *Spigelia* (Loganiaceae), *Andropogon* (Poaceae o Gramineae), and *Leptochloa* (Poaceae o Gramineae). Se proponen nuevos nombres en *Coreopsis* (Asteraceae o Compositae) y *Lithospermum* (Boraginaceae). Además discutimos la taxonomía y el rango apropiado de taxa adicionales que no requieren nuevas combinaciones en muchos de estos generos, basados en estudios recientes de herbario y de campo.

In preparation for the publication of a new state flora, the *Flora of Virginia* (Weakley, Ludwig, & Townsend, in prep.) and a new regional flora for a large portion of the southeastern United States, the *Flora of the Southern and Mid-Atlantic States* (Weakley, in prep.; Weakley 2011), as well as for general floristic, conservation, and scientific work in eastern North America, it is necessary to make a number of new combinations to accurately reflect current taxonomic understanding. Some of these changes are rank changes, while others are generic transfers

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to allow use of new (or re-adoption of old) generic concepts that are not fully reflected in available nomenclature at the specific or infraspecific levels.

ADOXACEAE

VIBURNUM

A reassessment of the *V. dentatum* group (Sorrie 2010) has resulted in the resurrection to specific rank of four taxa formerly much synonymized or "varietized" within *V. dentatum*: *V. scabrellum* (Torr. & A. Gray) Chapm. [= *V. semitomentosum* (Michx.) Rehder], *V. carolinianum* Ashe, *V. alabamemse* (McAtee) Sorrie [see below], and *V. venosum* Britton (Sorrie & Weakley 2011). All of these species are marked by highly distinct morphology and ranges and by little or no evidence of hybridization. Ironically, the segregate that has been most often recognized as a species or variety, *V. recognitum* Fernald (= *V. dentatum* var. *lucidum* Aiton), is morphologically the least distinctive component of the complex and may not warrant recognition at species rank. Pending further study, we retain *V. recognitum* at species rank, as its relative relationships to *V. dentatum* sensu stricto and other entities in the complex remain unclear.

Except for McAtee's monograph (1956), *Viburnum carolinianum* W.W. Ashe (Ashe 1918) has gone unrecognized for nearly a century; most authors subsuming it under *V. dentatum* L. The characters that separate *V. carolinianum*—uniformly large and rotund leaves, dense tomentum of stellate hairs on leaf undersides, stellate inflorescence branches, and strictly montane range—appear to be constant (31 specimens at NCU). *Viburnum carolinianum* slightly overlaps with *V. dentatum* sensu stricto in a few western NC counties, and the two maintain their succinct differences. We regard this as a distinct and relictual species, occupying a range of habitats, from river- and creek-banks to dry upland forests and granite outcrop edges. *Viburnum carolinianum* is a Southern Appalachian endemic, restricted to eastern Tennessee (Blount, Jefferson, and Polk counties), western North Carolina (11 counties), and northeastern Georgia (Rabun, Towns, Union, and White counties), a distribution very similar to that of many other "southern end of the Southern Blue Ridge" endemics (Weakley et al. in prep.).

A *Viburnum* entity from Alabama was originally named *V. recognitum* Fern. var. *alabamense* McAtee (McAtee 1953). McAtee maintained this disposition in a later monograph of the North American taxa (McAtee 1956). This taxon has generally been ignored since, but recent herbarium studies suggest that it is distinct from its relatives and warrants recognition. Taxon "*alabamense*" possesses the rotund-ovate leaf shape and stellate petiole characters of *V. dentatum*, and shares most inflorescence, flower, and fruit size and shape with both *V. dentatum* and *V. recognitum*. However, taxon "*alabamense*" has a few characters that strongly diverge from both *V. dentatum* and *V. recognitum*: stipitate-glandular cymes (vs. absence of stipitate hairs), cyme nodes and branches with simple hairs (vs. glabrous or with a few scattered stellate hairs), and fruits with densely glandular surfaces (vs. glabrous), warranting in our opinion elevated taxonomic rank. Taxon "*alabamense*" is apparently restricted to the Lookout Mountain region of northeastern Alabama in Cullman, DeKalb, and Marshall Counties (five specimens at NCU), approximately 240 km disjunct from the nearest populations of *V. dentatum* in eastern Georgia and western South Carolina. The Lookout Mountain area is otherwise known for some narrow endemics, and the narrow restriction of the taxon "*alabamense*" indicates that it warrants a level of conservation concern. In order to provide recognition of taxon "*alabamense*" at the species rank, a new combination is proposed.

Viburnum alabamense (McAtee) Sorrie, comb. et stat. nov. Basionym: *Viburnum recognitum* Fernald var. *alabamense* McAtee; Bull. Nat. Hist. Surv. Chicago Acad. Sci. 123:2. 1953. Type: U.S.A. Alabama. DeKalb Co.: low rocky east bank of west fork of Little River, near State Park on Lookout Mountain, 22 May 1942, *R.M. Harper* 3883 (GH).

Additional specimens cited: **U.S.A. Alabama. Cullman Co.:** rocky and alluvial woods, Mulberry Branch of Black Warrior River, N of U.S. 278 bridge, 28 Jun 1966, *R.C. Clark 3920* (NCU). **DeKalb Co.:** Valleyhead, 26 Jun 1918, *T.G. Harbison 4514* (NCU); Little River Canyon, De Soto State Park, 7 Aug 1975, *D. Demaree 52779* (NCU). **Marshall Co.:** near Town Creek on Sand Mountain, 26 May 1899, *Biltmore Herb. 1068d* (NCU); near highway 39 along Big Reedbreak Creek, SW of Douglas, floodplain over sandstone at base of sandstone bluff, 2 Aug 1974, *R.D. Whetstone 3260 with Atkinson and Springer* (NCU).

ASTERACEAE OR COMPOSITAE

COREOPSIS

Since its naming (Beadle 1898), the interpretation of *Coreopsis helianthoides* Beadle has varied, intermittently accepted as a good taxon but often lumped as a component of *C. gladiata* Walter. However, the "*helianthoides*" entity is highly distinctive from *C. gladiata*, its salient features under-appreciated by practically all authors except Ahles (1968). A few other authors have maintained it as a "good" taxon (Small 1933; Cronquist 1980, though his stated distribution is incorrect and apparently includes erroneously identified material), while most recent authors have explicitly or tacitly included it within *C. gladiata* (Smith 1976, 1983; Godfrey & Wooten 1981; Wunderlin & Hansen 2011; Duncan & Kartesz 1981; Jansen, Smith, & Crawford 1987; Strother in FNA (2006). Aside from its leaf arrangement, habit, and habitat, it is notable for the very broad achene wings relative to body width and for the short achene awns (average 0.8 mm). "*Coreopsis helianthoides*" often grows semiprostrate or with ascending stems, perhaps due to relatively frequent inundation. Of the species in this group, only "*C. helianthoides*" and *C. integrifolia* inhabit communities that are subject to river or stream overflow. "*Coreopsis helianthoides*" inhabits swamp forests and openings, fresh-tidal creek margins, marshes, and borrow ponds. It ranges near the coast from southeastern North Carolina to northeastern Florida (Duval County, where last collected in 1898). Georgia specimens of "*C. helianthoides*" are very rare—e.g., Camden County, 1 mile north of Kingsland, 18 Oct 1950, *R.K. Godfrey* 50908 (FSU, NCSC). Flowering dates are from mid-August to late October.

The confusion in this complex is underlined by the fact that Beadle's designated type for *Coreopsis helianthoides*—Aspalaga, Florida, Oct 1897, *A.W. Chapman s.n.* (holotype: Biltmore Herb., probably destroyed; isotypes MO!, US!)—is actually a specimen of *C. gladiata* Walter sensu stricto. It has broad-bladed leaves at all basal and lower culm nodes and was collected hundreds of kilometers outside of the known range of the "*helianthoides*" entity. Since the name *C. helianthoides* Beadle is thus a heterotypic synonym of the earlier *C. gladiata* Walter and there is no other existing name which applies to the species that has been interpreted as *C. helianthoides*, the species is described here with a new name and type that correctly describes these plants.

Coreopsis palustris Sorrie, sp. nov. (**Fig. 1**). TYPE: U.S.A. NORTH CAROLINA. Brunswick Co.: clearing bordering swamp forest and on stream bank, Bell Swamp near Winnabow, 27 Oct 1950, *R.K. Godfrey* 50957 (HOLOTYPE: NCSC!; ISOTYPES: FSU!, MO!).

Coreopsis gladiata similis sed differt caulibus ascendentibus vel paene prostratis, foliis basalibus ac caulinis inferis ad nodos quatuor vel plus tempore anthesis carentibus, foliis midcaulinis ellipticis, alis acheniorum 0.25 mm latis in quoque latere corpis, et aristis acheniorum peraeque 0.8 mm longis.

Similar to *Coreopsis gladiata* but stems ascending or nearly prostrate, basal and lower cauline leaves at four or more nodes absent during anthesis, mid-cauline leaves elliptical, achene wing 0.25 mm wide on each side of body, and achene awns average 0.8 mm long.

NABALUS

The interpretation that *Prenanthes* includes North American species has been repeatedly questioned over the past two centuries on many grounds: general morphology, achene vasculature, and molecular sequence data (Small 1933; Schilling & Floden, unpublished data). There now appears to be a general consensus to recognize *Nabalus* Cassini (1825) as a separate genus of North America and east Asia, as indicated by its recent acceptance in major worldwide synopses of the Asteraceae and indications based on molecular phylogenies that it is not even closely related to *Prenanthes* s.s. (Lack in Kadereit & Jeffrey 2007; Kilian, Gemeinholzer & Lack in Funk et al. 2009); morphological studies also support the separation of the two genera (Shih 1987).

Most North American species in this group have been treated in *Nabalus* in the past, as by Small (1933), but three North American taxa of this group lack valid names in *Nabalus* because of their recent naming, disagreement on their taxonomic recognition, or past nomenclatural confusions. These combinations are made here.

Nabalus autumnalis (Walter) Weakley, comb. nov. BASIONYM: *Prenanthes autumnalis* Walter, Fl. Carol 193. 1788. *Nabalus*

Fig. 1. Holotype of *Coreopsis palustris* Sorrie (NCSC).

virgatus DC., Prodr., 7(1):242. 1838, nom. superfl. & illeg.; *Prenanthes virgata* Michx., Fl. Bor.-Amer. 2:83. 1803, nom. superfl. & illegit. (based on *P. autumnalis* Walter).

Nabalus carrii (Singhurst, O'Kennon & W.C. Holmes) Weakley, comb. nov. BASIONYM: *Prenanthes carrii* Singhurst, O'Kennon & W.C. Holmes, Sida 21:187, fig. 2, 2004. TYPE: U.S.A. TEXAS. Bandera Co.: Lost Maples State Natural Area, above and below Upper Forks of Mystic Canyon Trail, 1 Sep 2001, *Singhurst & Singhurst 12496* (HOLOTYPE: BAYLU).

Nabalus trifoliolatus Cass. var. **nanus** (Bigelow) Weakley, comb. nov. BASIONYM: *Prenanthes alba* L. var. *nana* Bigelow, Fl. Boston, ed. 2:286. 1824.

PACKERA

Packera Á. Löve & D.Löve is now routinely accepted as a genus separate from *Senecio*, as indicated by its recent usage in *Flora of North America* (Trock in FNA 2006) and major worldwide synopses of the Asteraceae (Nordenstam et al. in Funk et al. 2009; Nordenstam in Kadereit & Jeffrey 2007). While the routine creation of hybrid binomials is questionable, the hybrid between the rare, southern Blue Ridge endemic *P. millefolium* (Torr. & A. Gray) W.A. Weber & Á. Löve and the more widespread and weedy *P. anonymus* (Alph.Wood) W.A.Weber & Á. Löve is well-documented, frequently collected, and has conservation implications because of its genetic swamping of the narrowly endemic *P. millefolium* at some populations (Gramling 2006). For these reasons, it is helpful for it to have a hybrid binomial in *Packera* for ease of reference in conservation and herbarium work.

Packera ×memmingeri (Britton ex Small) Weakley [*anonymus* × *millefolium*], comb. nov. BASIONYM: *Senecio memmingeri* Britton ex Small (pro sp.), Bull. Torrey Bot. Club 25:147. 1898.

Note also that the epithet "*millefolium*" in *Packera millefolium* (Torr. & A. Gray) W.A. Weber & Á. Löve is based on *Senecio millefolium* Torr. & A. Gray, and that they used it as a noun in apposition (in reference to *Millefolium* P. Miller, used for *Achillea* L.) rather than as an adjective, as also reflected by its capitalization in earlier floristic works (e.g., Torrey & Gray 1843; Chapman 1883; Small 1933; Fernald 1950); therefore the correct name in *Packera* is *Packera millefolium* (Torr. & A. Gray) W.A.Weber & Á. Löve, with the epithet "*millefolium*," not grammatically declined to "*millefolia*," as done by Trock in FNA (2006), Kartesz (1999, 2010), Barkley (1999), and other recent publications.

BORAGINACEAE

LITHOSPERMUM

The North American endemic genus *Onosmodium* Michx. has traditionally been regarded as distinct from the more widespread *Lithospermum* L. on the basis of several morphologic features, primarily the erect and acute corolla lobes and exserted style (as opposed to rounded and spreading corolla lobes and included style) (Al-Shehbaz 1991). Recent molecular studies show that *Onosmodium* is deeply embedded within *Lithospermum*, and that a re-evaluation of morphological features supposedly characteristic of *Onosmodium* reveals them as merely a more limited set of characters found in the morphologically more diverse *Lithospermum* (Weigend et al. 2009; Cohen & Davis 2009). While *Onosmodium* itself is a monophyletic group, interestingly with the southeastern North American *Lithospermum tuberosum* Rugel as a basal component (Weigend et al. 2009; Cohen & Davis 2009), its recognition at the generic rank renders *Lithospermum* paraphyletic and is also not warranted on the basis of morphological distinctiveness (the frequency of misidentifications between *Lithospermum* and *Onosmodium* is suggestive). Some combinations in *Lithospermum* for taxa of *Onosmodium* are already available [*Lithospermum virginianum* L., *Lithospermum molle* (Michx.) Muhl., *Lithospermum onosmodium* J. Cohen, *Lithospermum helleri* (Small) J.Cohen], but other currently recognized taxa of *Onosmodium* lack names in *Lithospermum*.

In transferring taxa of *Onosmodium* to *Lithospermum*, taxonomic rank is a complex issue requiring revisiting; while most of the currently recognized taxa have been universally and uncontroversially recognized as taxa by modern workers, the taxonomic rank at which they have been recognized has been variable, involving specific, subspecific, and varietal designations. The complex involving taxonomic entities "*molle*," "*hispidissimum*," "*subsetosum*," "*occidentale*," and (sometimes) "*bejariense*" has been particularly variable in treatment,

with entities either recognized as species (Mackenzie 1905; Fernald 1950; Gleason 1952), as varieties under *O. molle* (Gleason & Cronquist 1991), as subspecies under *O. molle* (Cochrane 1976; Al-Shehbaz 1991), as subspecies more broadly under *O. bejariense* (Turner 1995), lumped entirely as *O. molle* (Small 1933), or apparently but ambiguously lumped (Cohen & Davis 2009).

Turner (1995) referred to the taxa in this complex (from which he excluded *O. molle*) as "morphogeographical taxa," treated them as varieties of *O. bejariense*, mapped them as completely or nearly allopatric (Turner 1995, figs. 1–5), and stated that "in regions of contact, intermediates between these morphogeographical taxa commonly occur." Our experiences and those of many other botanists active in the southeastern United States suggest a different situation, with two or more taxa often sympatric and morphologically distinctive in various regions of the Southeast, and sometimes occurring together at individual sites. For instance, four entities ("*molle*," "*hispidissimum*," "*subsetosum*," and "*occidentale*") all occur in close proximity in the Interior Low Plateau and Eastern Highland Rim of Tennessee (UTK & APSU 2011) and adjacent states, such as Alabama (Datillo & Nestor 2011), while Turner (1995) mapped only two entities east of the Mississippi River, apparently based on a sparse sampling of only a total of six county records from Tennessee, Alabama, Mississippi, and Kentucky for the complex of *hispidissimum* + *subsetosum* + *occidentale* (excluding *molle*).

A pattern of sympatry of these taxa across portions of the southeastern United States, with two or more species sometimes co-occurring at a site and maintaining overall morphological distinctiveness, their maintenance of characters in common garden situations, and their manifestation of biogeographic patterns seen in many other genera (for instance, the disjunction, presumably relictual, of Interior Highlands [Ozark/Ouachita] taxa to the Interior Low Plateau and adjacent Eastern and Western Highland Rims) suggests that specific status better reflects the current relationship of these undoubtedly closely related entities (Weakley et al., in prep.). The majority of southeastern field botanists familiar with these taxa in the field regard them as being best treated at specific rank. Furthermore, nomenclatural stability of the taxa in this complex has not been well served by their treatment at three different ranks (species, subspecies, and variety) and by their variable inclusion / exclusion in the complex of *O. molle*, the oldest entity, therefore resulting in infraspecific combinations at two ranks and under two different species (*O. molle* and *O. bejariense*) (see synonymy listed below). In-progress studies by A.S. Weakley, C.T. Witsell, and L.D. Estes suggest that *O. molle* does not appear to be more strongly offset from the taxa treated by Turner (1995) as varieties of *O. bejariense* than they are from one another. It is therefore our opinion that biological reality and nomenclatural stability are both best served by treating these taxa at specific rank, and in *Lithospermum*. We make the following additional new combinations to complement those already available in *Lithospermum*.

Lithospermum decipiens (J.R. Allison) Weakley, Witsell & D. Estes, comb. nov. Basionym: *Onosmodium decipiens* J.R. Allison, Castanea 66:180, Fig 10, 2001. Type: U.S.A. Alabama. Bibb Co.: ca. 13.7 km NE of Centreville, "Fern Glade," Ketona Dolomite outcrop above the right (N) bank of the Little Cahaba River, 1 Nov 1993, *James R. Allison and Timothy E. Stevens 8139* (holotype, NY; isotypes: AUA, DUKE, GA, GH, JSU, MICH, MO, UNA, US, VDB).

Lithospermum occidentale (Mack.) Weakley, Witsell & D. Estes, comb. nov. Basionym: *Onosmodium occidentale* Mack., Bull. Torrey Bot. Club 32:502. 1905. *Onosmodium molle* Michx. var. *occidentale* (Mack.) I.M. Johnston, Contr. Gray Herb. 70:18. 1924. *Onosmodium molle* Michx. ssp. *occidentale* (Mack.) T.S. Cochrane, Michigan Bot. 15:104. 1976. *Onosmodium bejariense* A.DC. var. *occidentale* (Mack.) B.L. Turner, Phytologia 78:46. 1995.

Lithospermum parviflorum Weakley, Witsell & D. Estes, nom. nov. Basionym: *Onosmodium hispidissimum* Mack., Bull. Torrey Bot. Gard 32:500. 1905, non *Lithospermum hispidissimum* Lehmann (1823). *Onosmodium molle* Michx. var. *hispidissimum* (Mack.) Cronquist. *Onosmodium molle* Michx. ssp. *hispidissimum* (Mack.) Cochrane, Michican Bot. 15:104. 1976. *Onosmodium bejariense* A.DC. var. *hispidissimum* (Mack.) B.L. Turner, Phytologia 78:45. 1995. As the epithet "*hispidissimum*" is blocked from transfer to *Lithospermum* by its unsurprisingly prior usage in that very hispid genus, a new name is required. We have selected the epithet "*parviflorum*" to emphasize the smaller flowers of this taxon as compared to its relatives in the *Lithospermum onosmodium* complex.

Lithospermum subsetosum (Mack. & Bush) Weakley, Witsell & D. Estes, comb. nov. Basionym: *Onosmodium subsetosum* Mack. & Bush, in J.K. Small, Fl. S.E. U.S. 1001. 1903. *Onosmodium molle* Michx. var. *subsetosum* (Mack. & Bush) Cronquist. Vasc. Pl. Pacific NorthW. [C.L. Hitchcock et al.] 4:234. 1959. *Onosmodium molle* Michx. ssp. *subsetosum* (Mack. & Bush) Cochrane, Michigan Bot. 15:104. 1976. *Onosmodium bejariense* A.DC. var. *subsetosum* (Mack. & Bush) B.L. Turner, Phytologia 78:47. 1995.

HYMENOPHYLLACEAE

CREPIDOMANES

Recent phylogenetic and other studies of the Hymenophyllaceae have emphasized the diversity of evolutionary groups, especially in what has often been treated as a broadly defined *Trichomanes* L. Specifically, the recognition of smaller, morphologically more homogeneous clades within *Trichomanes* s.l. has been recently promoted by Ebihara et al. (2006, 2007). Three strikingly different species of *Trichomanes* sensu lato are distributed in temperate eastern North America: *T. boschianum* Sturm, *T. petersii* A. Gray, and *T. intricatum* Farrar. They fall into three different clades within *Trichomanes* s.l., and correspondingly within three separate segregate genera, as recognized by Ebihara et al. (2006, 2007). The first two have existing names in their appropriate segregate genera, *Vandenboschia boschiana* (Sturm) Ebihara & K. Iwats. and *Didymoglossum petersii* (A. Gray) Copel., respectively, while the third does not. *Trichomanes intricatum* is an interesting and indeed seemingly intricate case. Ebihara, Farrar, and Ito (2008) used chloroplast molecular sequence data to determine that *T. intricatum* is very closely related to *Crepidomanes schmidtianum* (Zenker ex Tasch.) K. Iwats. var. *schmidtianum*. While this might be used as evidence to merge them, the following factors argue against such a course, at least pending future research to definitely determine their evolutionary relationship: 1) *T. intricatum* is a free-living gametophytic species, in contrast with *C. schmidtianum*, which has a standard sexual alternation of sporophytic and gametophytic generations, 2) all known samples of the ploidy of *C. schmidtianum* show it to be sterile triploid, while the ploidy of *T. intricatum* is unknown (Ebihara, Farrar, & Ito 2008), and 3) *T. intricatum* is isolated in North America from the remainder of *Crepidomanes*, which is Old World, a seemingly relictual distribution, and can reasonably be judged to be on an independent evolutionary trajectory from its Old World *Crepidomanes* congeners. For these reasons, we opt to continue to recognize *T. intricatum* as a separate species of enigmatic origin and to transfer it to its appropriate generic affiliation.

Crepidomanes intricatum (Farrar) Ebihara & Weakley, comb. nov. Basionym: *Trichomanes intricatum* Farrar, Amer. Fern J. 82:68–69, figs. 2, 3, 1992. Type: U.S.A. Illinois. Hardin Co.: Hooveh Hollow, along base of north-facing cliffs of Pottsville sandstone along Rock Creek, 6 Jan 1982, *D. Farrar 82-1-6-6* (holotype ISC; isotypes NY, US, MICH, US, MO).

HYPERICACEAE

HYPERICUM

Hypericum densiflorum Pursh is a wide-ranging species of the Atlantic Coastal Plain and Appalachian Mountains, from New Jersey and West Virginia south to South Carolina and Alabama. Adams (1962, 1973) noted that the distribution is discontinuous and restricted to five discrete regions: the coastal plain of New Jersey, Delaware, and Maryland; coastal plain of North and South Carolina; Allegheny Plateau of Pennsylvania, Maryland, and West Virginia; Blue Ridge of Virginia and North Carolina; and Ridge and Valley of Tennessee, Georgia, and Alabama. Despite the suggestive taxonomic possibilities inherent in five allopatric population centers, only the Ridge and Valley plants have been accorded separate status, as *H. interior* Small (= *H. revolutum* Keller). The narrow, somewhat revolute leaves of these plants prompted Small (1901, 1933) and Keller (1923) to separate *H. interior* as specifically distinct. However, authors since Small have not recognized *H. interior*, nor have they recognized any infraspecific taxa in *H. densiflorum*.

We could find no discernible differences among any of the five *H. densiflorum* populations regarding capsule length and seed morphology. Capsules ranged from 4.0–6.5 mm regardless of collecting locality. In fact, this measurement varied as much on any given specimen as it did among populations. Seeds ranged from 0.8–1.1 mm regardless of locality, with one exception: 1.1–1.3 mm in Garrett County, Maryland (Downs 7777, NCU), which we consider to be anomalous. Seed ornamentation did not vary across the range of *H. densiflorum*: all had pits in uniform rows of even width. The sample size of fruiting plants at NCU was relatively small, since the great majority of specimens were collected in flower, so that additional measurements from other herbaria may alter our data relative to seed ornamentation.

The leaf width data, however, were distinctly bimodal (Table 1). The Ridge-and-Valley population has

TABLE 1. Mean and range of leaf width for populations of *Hypericum densiflorum*.

Population	mean leaf width in mm	range of leaf width in mm
Coastal Plain NJ–DE	5.7	3.5–7.9(–8.2)
Coastal Plain NC–SC	4.7	(2.8–)3.0–7.0(–8.2)
Allegheny Plateau PA–MD–WV	5.3	(3.0–)3.6–6.8(–7.6)
Blue Ridge VA–NC	5.4	(1.8–)2.8–8.3(–9.2)
Ridge-and-Valley TN–GA–AL	2.0	(0.9–)1.0–3.7

leaves that average less than half that of the other four populations. Ridge-and-Valley plants consistently exhibit narrow leaves, with no intermediacy or clinal tendancy.

The geographic structure of the variation in leaf width argues for recognition of a taxon, but since leaf width seems to be the only reliable character which distinguishes entity "*interior*" from the remainder of entity "*densiflorum*," we conservatively choose to treat "*interior*" at varietal rank.

Hypericum densiflorum Pursh var. **interior** (Small) Sorrie & Weakley, comb. et stat. nov. BASIONYM: *Hypericum interior* Small, Bull. Torrey Bot. Club 28:359–360. 1901. TYPE: U.S.A. TENNESSEE. JEFFERSON COUNTY: ad rivulos prope Dandridge, Jul 1842, *Rugel s.n.* (HOLOTYPE: NY!, image examined online).

LOGANIACEAE

SPIGELIA

Katherine Gould Mathews conservatively chose varietal status when she (as K. Gould) named a plant discovered by Allison and Stevens (2001) at the dolomitic Ketona glades in Bibb County, Alabama, at the southern end of the Ridge and Valley Province, which showed affinity to the extremely rare *S. gentianoides* Chapm. ex A.DC. of Florida and southern Alabama longleaf pinelands. The subsequent publication of about a dozen highly distinctive, new vascular plant taxa (mainly at species rank) from this site (Allison & Stevens 2001; Kral & Moffett 2009) have since emphasized the Ketona glades as a major site of the evolutionary generation of endemics, and the retention of ancient relictual taxa, at this southernmost edge of the Appalachian Mountains. A recent conservation assessment of *S. gentianoides* and its two varieties (USFWS 2009) suggests the possibility that the two taxa warrant specific rank. Gould (1996) lists numerous and strong character state differences (many of them discrete and non-overlapping) between the two taxa. Reassessing the appropriate ranks of these taxa by any of various modern "species concepts" and by standards of taxonomic rank normally applied regionally and to taxa in the genus *Spigelia*, we now judge that specific rank is warranted, though additional molecular and morphological studies should be conducted to corroborate this treatment.

Spigelia alabamensis (K. Gould) K.G. Mathews & Weakley, comb. et stat. nov. BASIONYM: *Spigelia gentianoides* Chapm. ex A.DC. var. *alabamensis* K.Gould, Sida 17:418. 1996. TYPE: U.S.A. ALABAMA. Bibb Co.: large Ketona dolomite glade on hillside above the Little Cahaba River from County Road 65, off Hwy. 25, 30 May 1996, *Katherine Gould 145 & Sheryl Gould* (HOLOTYPE: TEX; ISOTYPES: FLAS, FSU, GA, GH, UNA).

OLEACEAE

CARTREMA

A number of recent studies (morphological, anatomical, and molecular) have suggested that *Osmanthus* Lour. as generally and recently circumscribed is paraphyletic (summarized in Guo et al. 2011). The most obvious discordant element is the section *Leiolea* (Spach) P.S. Green, morphologically distinguished most obviously by its paniculate inflorescences (contrasting with the fascicled inflorescences of *Osmanthus* sensu stricto) and occurring in eastern and southeastern Asia, and southeastern North America south to Mexico and Central America (Green 1958). J.K. Small (1933) recognized the distinctiveness of this element and created the genus *Amarolea* Small to accommodate the two entities, "*americanus*" and "*megacarpus*," distributed in the southeastern United States. Rafinesque had presaged this by nearly a century, however, establishing the genus *Cartrema*

Rafinesque in 1838 with his trademark combination of perception and sloppiness, the genus required a renaming via a correction in the original, and in addition to transferring *Olea americana* L. to *Cartrema*, he two years later published a second, and therefore illegitimate, epithet for the same taxon [*Cartrema odorata* (Raf.) Raf.].

While the molecular phylogenetic study of Guo et al. (2011) does not resolve all the issues with generic circumscription in subtribe Oleinae, it does clearly establish that section *Leiolea* is monophyletic, and falls in a larger clade with *Olea* and *Linociera*, not *Osmanthus* sensu stricto. We therefore accept *Cartrema* Raf. as the appropriate generic placement for the group of taxa formerly treated in *Osmanthus* section *Leiolea*. *Cartrema americana* (L.) Raf. was established by Rafinesque, but *Osmanthus megacarpus* (Small) Small ex Little requires a new combination (made below); we agree with recent authors who have opted to treat this taxon at specific rank (e.g., Wunderlin & Hansen 2011). Other taxa in section *Leiolea* (as treated by Green 1958) distributed in Mexico, Central America, and eastern and southeastern Asia apparently also warrant transfer to *Cartrema*, but we refrain from making these transfers at this time, as the appropriate specific and varietal treatment remains unclear and is beyond the scope of this study.

Cartrema megacarpa (Small) Weakley, comb. nov. BASIONYM: *Amarolea megacarpa* Small, Man. S.E. Fl. 1043. 1933. TYPE: U.S.A. FLORIDA. Highlands Co.: near Lake Annie, 8 Jan 1925, *J.K. Small & Matthaus 11612* (HOLOTYPE: NY).

Osmanthus megacarpus (Small) Small ex Little, J. Wash. Acad. Sci. 33:10. 1943.

POACEAE

ANDROPOGON

We admire and commend Campbell's (1983) monograph, which rightly returned botanists to the recognition of numerous taxa in the "*A. virginicus* complex," following the extremely broad treatment of the group by Radford (1968) in the regionally influential *Manual of the Vascular Flora of the Carolinas* (Radford, Ahles, & Bell 1968). In the number and circumscription of taxa, Campbell's (1983) conclusions closely resemble those of Hackel (1889), suggesting that taxonomy does not always progress forward in a straightforward path towards the truth. We also appreciate Campbell's (1983) use of a kind of numerical scale to determine the appropriate taxonomic rank of entities he considered worthy of recognition, with 3 or fewer reliable character state differences meaning an informal rank distinction of "variant," 4–6 meaning formal varietal distinction, and 7–9 meaning formal specific distinction, as a tool to render new order out of the then recently past and simplistic chaos. Several decades after Campbell's insightful work, the observable biological realities of this complex of taxa clearly warrant new opinions on taxonomic rank. Campbell (1986) himself provided some preliminary reassessments, elevating some taxa formerly treated as informal "variants" to formal taxonomic status based on a "phylogenetic reconstruction" of the group, although other groupings made by Campbell of formal (variety) and informal ("variants") within species were not supported by the analysis, or only weakly so.

After an examination of the literature, herbarium specimens, and living populations, we conclude that the three striking, chalky-white bluestem grasses of the southeastern United States Coastal Plain—*A. capillipes* Nash, *A. dealbatus* (C. Mohr) Weakley & LeBlond (combination made below), and *A. glaucopsis* Elliott—are distinctive as species. Plants referable to *A. glaucopsis* and *A. capillipes* have been recognized as species or varieties in several treatments since the mid-20th century (Fernald 1950; Hitchcock and Chase 1951; Godfrey and Wooten 1979; Campbell 1983; Wunderlin and Hansen 2011; Campbell 2003). During that same period, plants referable to *A. dealbatus* have been treated in synonymy with *A. capillipes*. Following the original published descriptions of *A. capillipes* (as *A. virginicus* L. var. *glaucus* Hackel) and *A. dealbatus* (as *A. virginicus* var. *dealbatus* C. Mohr) by Hackel (1889), the three taxa had not been treated together until the landmark monograph of the *Andropogon virginicus* complex by Campbell (1983). Campbell chose not to treat *A. capillipes* and *A. dealbatus* as formally distinct and instead treated them as informal variants comprising a single taxon, *A. virginicus* var. *glaucus*. Plants referable to *A. capillipes* he called the "drylands variant" and those referable to *A. dealbatus* were called the "wetlands variant."

Andropogon capillipes, *A. dealbatus*, and *A. glaucopsis* are most readily separated from other members of the *A. virginicus* complex by the strongly chalk-white leaves (*A. perangustatus* Nash and Campbell's "smooth

variant" of *A. virginicus* var. *virginicus* can have slightly glaucous leaves). *Andropogon glaucopsis* is further separated from *A. capillipes*, *A. dealbatus*, and *A. virginicus* sensu lato (sensu Campbell) by ligule and leaf blade lengths. In *A. glaucopsis*, the membranous portion of the ligule is (0.9–)1.5(–2.0) mm long, while in the other taxa collectively it is (0.2–)0.3–0.5(–1.0) mm long. Length of cilia terminating the ligule also differ, with those of *A. glaucopsis* 0–0.2 mm long and those of the others collectively 0.2–1.3 mm long. Leaf blades are (33–) avg. 40(–75) cm long in *A. glaucopsis* and collectively (11–)17–30(–52) cm long in *A. capillipes*, *A. dealbatus*, and *A. virginicus* sensu lato.

Campbell (1983) states that the "strong overlap in the characters separating the drylands and wetlands variants and the breakdown in the correlation of these characters in about five percent of all populations examined in the herbarium are the reasons these two taxa are not recognized nomenclaturally." But Campbell (1983) also found that in "the majority of instances .. morphological and soil-moisture differences are correlated. I have seen these taxa growing within one to three meters of one another at three localities in northwestern Florida. At only one of these was there difficulty in classifying any individual: a single plant on a slope between a bog inhabited by the wetlands variant and a roadside lined with the drylands variant combined the morphological features of these two taxa."

Ideally, taxonomic decisions should be based on the behavior of natural populations rather than on herbarium specimens, which are extremely useful but sometimes imperfect or even misleading representations of wild plant populations. Our own experience and that of many other field botanists in the southeastern United States suggest that the two entities are strongly distinct. Many taxa recognized as species (correctly in our opinion) are represented in herbaria by well more than 5% of specimens that are not confidently and definitely identifiable, because of specimen conditions. In field work involving all states in the ranges of these two taxa, we have not found a single plant from living populations that was not readily assignable to one taxon or the other, and Campbell (1983) himself indicates finding only that single individual that was ambiguous in live condition.

In our own examination we have found a consistent correlation between spikelet length and the presence/absence of pubescence (longish hairs) below the raceme sheath and an overlapping but supportive alignment of raceme sheath length, raceme axis length, average leaf width, and upper floret lemma awn length. As noted by Campbell, habitat differences also help to distinguish these taxa. *Andropogon capillipes* is found in dry to mesic pinelands and adjacent roadbanks, while *A. dealbatus* prefers wet savannas, depressional wetlands, and adjacent ditches. *Andropogon capillipes* also occurs over a narrower range, from southeastern North Carolina south to Florida and west to Alabama. *Andropogon dealbatus* is more disjunctly widespread, occurring in southern New Jersey; North Carolina south to Florida and west to Texas; and the Bahamas (Sorrie & LeBlond 1997). Fernald (1950) cited southeastern Virginia as the northern limit for *A. capillipes*, but Campbell did not cite a Virginia specimen, nor have we been able to locate one.

In our opinion, *Andropogon glaucopsis* Elliott is not only distinct from the two smaller chalky bluestems (*A. capillipes* and *A. dealbatus*) but also from *A. glomeratus*, with which it has sometimes been related at varietal rank. Its morphology and distribution seem to us sharply distinct, and it co-occurs frequently and abundantly with *A. glomeratus*, with no signs of intergradation. *Andropogon glaucopsis* therefore behaves as a species and warrants specific rank (Weakley 2011; E. Bridges & S. Orzell, pers. comm.).

The following key distinguishes the strongly white-waxy-leaved species from one another.

1. Ligule 0.9–2.0 mm long, averaging 1.5 mm, with cilia 0–0.2 mm long; raceme sheaths (1.3–)2.0–2.5(–3.0) mm wide, (2.0–)2.4–3.6(–4.4) cm long; leaf blades (33–) avg. 40(–75) cm long _____ **A. glaucopsis**
1. Ligule 0.2–0.5 mm long, with cilia 0.3–1.2 mm long; raceme sheaths (2.7–)3.0–4.2(–5.5) mm wide, (2.1–)2.6–4.8(–6.0) cm long; leaf blades (12–) avg. 19(–38) cm long.
    2. Summit of branchlet below attachment of raceme sheath glabrous; spikelets (2.6–)3.2–3.5(–3.9) mm long; raceme sheaths (2.1–)2.6–3.8(–4.9) cm long; racemes (1.4–)1.7–2.4(–3.2) cm long; leaves (2–) avg. 3.5(–5) mm wide; upper floret lemma awn (0.6–) avg. 1.1(–1.5) mm long; plant of dry to mesic pinelands and roadbanks _____ **A. capillipes**
    2. Summit of branchlet below attachment of raceme sheath pubescent with ascending hairs 2–4 mm long; spikelets (3.0–)3.5–3.9(–4.4) mm long; raceme sheaths (2.4–)3.2–4.8(–6.0) cm long; racemes (1.5–)2.0–3.0(–4.0) cm long; leaves (2.5–)5(–6.5) mm wide; upper floret lemma awn (0.9–) avg. 1.4(–2.1) mm long; plant of wet pinelands and ditches _____ **A. dealbatus**

Andropogon perangustatus Nash has sometimes been treated at varietal rank relative to *A. gyrans* W.W. Ashe, as *A. gyrans* var. *stenophyllus* (Hackel) C.S. Campbell, but it seems to us only tenuously related to *A. gyrans* and very distinct based on multiple morphological characters, different habitats, and different (though overlapping) distributions. The two taxa sometimes occur in close proximity in the southeastern Coastal Plain and show habitat fidelity and an apparent absent of any hybrids, intergrades, or morphological intermediates. We therefore also treat this taxon at specific rank (Weakley 2011, E. Bridges & S. Orzell, pers. comm.).

The southeastern Coastal Plain endemic *Andropogon mohrii* Hackel also seems to warrant specific status rather than treatment at varietal rank under *A. liebmannii* Hackel, as var. *pungensis* (Ashe) C.S. Campbell (Weakley 2011). Uniting the two as varieties of *A. liebmannii* implies that they are most closely related to one another, and perhaps they are, but Campbell (1986) provided no support for their monophyly. Even if sister taxa, specific status seems warranted by their morphological differences and allopatric distributions.

Andropogon tenuispatheus (Nash) Nash (the "robust variant" of *A. glomeratus* var. *pumilus* of Campbell [1983], becoming equivalent to *A. glomeratus* var. *pumilus* upon removal of the "southwestern variant" as *A. glomeratus* var. *scabriglumis* Campbell [Campbell 1986, 2003]) also warrants distinction at specific rank from *A. glomeratus*. Based on morphology, ecology, and distribution, there seems to be no reason not to recognize these taxa as distinct species (Weakley 2011).

The elevation (or re-elevation in most cases) of various "*glomeratus*" entities to specific rank highlights the status of the "*hirsutior*" entity, variously lumped in *A. virginicus* (Radford, Ahles, & Bell 1968)), lumped in *A. glomeratus* (Hitchcock & Chase 1951, Small 1933), treated as a variety of *A. virginicus* as *A. virginicus* var. *hirsutior* (Hackel) A.S. Hitchcock, or treated as a variety of *A. glomeratus* (Campbell 1983, 2003). The "*hirsutior*" entity frequently co-occurs with *A. glomeratus* and *A. glaucopsis*, all three often being abundant at the same site with no signs of introgression or intermediacy, and all individuals being easily identified as one of the three entities. Campbell (1983) also established that the somewhat superficially similar "*glaucopsis*" entity and "*hirsutior*" entity are genetically distinct. Campbell's (1986) analysis suggested that the "*hirsutior*" entity is most closely related to the "*glaucopsis*" entity, but we do not regard it as conspecific with either "*glaucopsis*" or "*glomeratus*" for the reasons stated above. We therefore believe that specific status is warranted for this entity, as suggested by Weakley (2011).

Two new combinations are needed to implement this taxonomic scheme.

Andropogon dealbatus (C. Mohr) Weakley & LeBlond, comb. et stat. nov. Basionym: *Andropogon virginicus* var. *dealbatus* C. Mohr in A.L.P.P. de Candolle & A.C.P. de Candolle, Monogr. Phan 6:411. 1889. Type: U.S.A. Alabama. Mobile Co.: Mobile, 1884, *Mohr s.n.* (holotype: W).

Informal synonym: *A. virginicus* L. var. *glaucus* Hackel in DC. "wetlands variant" in the sense of Campbell (1983, 2003).

Andropogon hirsutior (Hackel) Weakley & LeBlond, comb. et stat. nov. Basionym: *Andropogon macrourus* Michx. var. *hirsutior* Hackel in A.L.P.P. de Candolle & A.C.P. de Candolle, Monogr. Phan. 6:411. 1889. Type: U.S.A. Alabama. Mobile Co.: Mobile, 28 Oct 1884, *Mohr s.n.* (holotype: W).

Andropogon glomeratus Britton, Sterns, & Poggenb. var. *hirsutior* (Hackel) C. Mohr, Bull. Torrey Bot. Club 24:21. 1897.

COLEATAENIA

As part of the ongoing dismantling of *Panicum* into more natural and monophyletic units, Zuloaga, Scataglini, & Morrone (2010) proposed that taxa previously treated within *Panicum* sects. *Agrostoidea* and *Tenera* should be placed in a new genus *Sorengia* based on morphological and molecular characters. Following publication, it was determined by Soreng (2010) that the new generic name *Sorengia* was illegitimate, as the type of an older legitimate generic name, *Coleataenia*, was included as a synonym within one of the species of the new genus.

As explained below under each new combination, we differ as to the most appropriate taxonomic rank at which some of the entities in this group should be recognized.

Coleataenia abscissa (Swallen) LeBlond, comb. nov. Basionym: *Panicum abscissum* Swallen, J. Wash. Acad. Sci. 30:215, f.4. 1940. *Panicum rigidulum* Bosc ex Nees ssp. *abscissum* (Swallen) Freckmann & Lelong, Sida 20:172. 2002. *Sorengia longifolia* (Torr.) Zuloaga & Morrone ssp. *abscissa* (Swallen) Zuloaga & Morrone, Taxon 59:1542. 2010. *Coleataenia longifolia* (Torr.) Soreng ssp. *ab-*

scissa (Swallen) Soreng, J. Bot. Res. Inst. Texas 4:691. 2010. TYPE: U.S.A. FLORIDA. Highlands Co.: Sebring, in dry sand at tourist camp near lake, 3 Oct 1925, *Weatherwax s.n.* (HOLOTYPE: US).

This central Florida endemic is returned to species rank due to the unique structure of the sheath summit, ligule, and blade base. There is no known introgression with other taxa. Within its limited range, it is often the dominant herbaceous plant in moist flatwoods and depressions.

Coleataenia rigidula (Bosc ex Nees) LeBlond ssp. **condensa** (Nash) LeBlond, comb. et stat. nov. BASIONYM: *Panicum condensum* Nash, Fl. S.E. U.S. 93, 1327. 1903. *Panicum agrostoides* Sprengel var. *condensum* (Nash) Fernald, Rhodora 36:74. 1934. *Panicum rigidulum* Bosc ex Nees var. *condensum* (Nash) Mohlenbr., Ill. Ind. Bot. 71. 1973. TYPE: U.S.A. FLORIDA. Duval Co.: near Jacksonville, 16 Oct 1895, *Curtiss 5576* (HOLOTYPE: NY; ISOTYPES: MO, US).

Although Gleason (1952) stated that the "*Panicum condensum* entity" intergraded "completely" with "*P. agrostoides* var. *agrostoides*" (what is here called *Coleataenia rigidula* ssp. *rigidula*), he nonetheless provided distinguishing characters, suggesting some ambivalence. This taxon's striking habit, tendency for larger spikelets, and restriction to the Coastal Plain support continued recognition of a distinctive genetic trend.

Coleataenia rigidula (Bosc ex Nees) LeBlond ssp. **rigidula**, comb. nov. BASIONYM: *Panicum rigidulum* Bosc ex Nees, Fl. Bras. Enum. Pl. 2:163. 1829. *Sorengia longifolia* (Torr.) Zuloaga & Morrone ssp. *rigidula* (Bosc ex Nees) Zuloaga & Morrone, Taxon 59:1542. 2010. *Coleataenia longifolia* (Torr.) Soreng ssp. *rigidula* (Bosc ex Nees) Soreng, J. Bot. Res. Inst. Texas 4:691. 2010. TYPE: U.S.A. *Bosc s.n.* (HOLOTYPE).

Panicum agrostoides Muhl., Descr. Gram. 119. 1817, nom. illeg., non Spreng. (1815). TYPE: "Muhlenberg Herbarium deposited by American Philosophical Society," *Muhlenberg 177*. (LECTOTYPE: PH).

Panicum elongatum var. *ramosior* C. Mohr, Contr. U.S. Natl. Herb. 6:357. 1901. *Panicum agrostoides* var. *ramosius* (C. Mohr) Fernald, Rhodora 38:390. 1936. TYPE: U.S.A. ALABAMA. Mobile Co.: Pierce's Landing, Oct 1885, *Mohr s.n.* (HOLOTYPE: US).

The distinctive difference in ligule structure between *Coleataenia longifolia* sensu stricto and *C. rigidula* entities (including *C. stipitata*) argues for a taxonomic split at the species rank. The *longifolia* ligule is comprised of white hairs 0.5–3 mm long, while the *rigidula* ligule is a tawny membrane 0.3–1 mm long. The leaves of *longifolia* are usually pubescent and folded or involute, while the mostly wider leaves of *rigidula* are glabrous and flat. Upper leaves are characteristically shorter than the panicles in *longifolia*, and more-or-less equal to the panicles in *rigidula*.

Coleataenia stipitata (Nash) LeBlond, comb. nov. BASIONYM: *Panicum stipitatum* Nash, Bull. Div. Agrostol., U.S.D.A. 17:56. 1901. *Panicum elongatum* Pursh, Fl. Amer. Sept. 1:69. 1814, nom. illeg., non Salisb. (1796). *Panicum agrostoides* var. *elongatum* Scribn., Bull. Agric. Exp. Sta. Univ. Tennessee 2:42. 1894. *Panicum rigidulum* Bosc ex Nees var. *elongatum* (Scribn.) Lelong, Brittonia 36:263. 1984. *Panicum rigidulum* Bosc ex Nees ssp. *elongatum* (Pursh) Freckmann & Lelong, Sida 20:172. 2002, corrected to *Panicum rigidulum* Bosc ex Nees ssp. *elongatum* (Scribn.) Freckmann & Lelong in Flora of North America 25:478. 2003. *Sorengia longifolia* (Torr.) Zuloaga & Morrone ssp. *elongata* (Scribn.) Zuloaga & Morrone, Taxon 59:1542. 2010. *Coleataenia longifolia* (Torr.) Soreng ssp. *elongata* (Scribn.) Soreng, J. Bot. Res. Inst. Texas 4:691. 2010. TYPE: U.S.A. DELAWARE: *Pursh s.n.* (LECTOTYPE: K; US, photo; ISOLECTOTYPE: US, fragment).

Occasional specimens approach *Coleataenia rigidula* ssp. *rigidula* but can be distinguished by the stipitate upper lemma.

DICHANTHELIUM SECTION ANGUSTIFOLIA

Dichanthelium neuranthum (Griseb.) LeBlond, comb. nov. BASIONYM: *Panicum neuranthum* Griseb., Cat. Pl. Cub. 232. 1866. *Dichanthelium aciculare* (Desvaux ex Poiret) Gould & C.A. Clark ssp. *neuranthum* (Griseb.) Freckmann & Lelong, Sida 20:167. 2002. TYPE: CUBA: Oriente, 1860, *Wright 3453* (LECTOTYPE: US).

Panicum ovinum Scribn. & J.G. Sm., Circ. Div. Agrostol. U.S.D.A. 16:3. 1899. TYPE: U.S.A. TEXAS. Waller Co.: 25 May 1898, *Thurow s.n.* (HOLOTYPE: US).

Panicum pinetorum Swallen, Proc. Biol. Soc. Wash. 55:93. 1942. TYPE: U.S.A. FLORIDA. Lee Co: open pine woods near Bonita Springs, 14 Oct 1940, *Silveus 6604* (HOLOTYPE: US; ISOTYPE: TEX, US).

Panicum ridivivum Trin. ex Steud., Nomencl. Bot., ed. 2:262. 1841, nomen nudum. TYPE: MEXICO: Hacienda de la Laguna, n.d., *Schiede 37* (HOLOTYPE: LE; ISOTYPE: US, fragment ex LE).

Dichanthelium neuranthum is another uncommon to rare species that may be overlooked because of its resem-

blance to other taxa, especially the autumnal form of *D. aciculare* (Desvaux ex Poiret) Gould & C.A. Clark and vernal form of *D. caerulescens* (Hackel ex Hitchcock) Correll. It appears to be most closely related to *D. aciculare* and has commonly been placed in synonomy with that taxon. *Dichanthelium neuranthum* is distinguished from *D. aciculare* by having glabrous internodes and sheaths (at least the lower pubescent to villous in *D. aciculare*), vernal blades 5–15 cm long (4–8 cm in *D. aciculare*) and first glumes 0.7–1.0 mm long (0.6–0.8 mm in *D. aciculare*). The mature panicle in *D. neuranthum* is often no more than 0.5–2 cm wide, especially among populations along the Atlantic Coastal Plain, with erect-ascending branches and sub-secund spikelets few in number. *Dichanthelium neuranthum* is most readily distinguished from the vernal form of *D. caerulescens* by having pubescent spikelets 1.8–2.2(–2.8) mm long (glabrous and 1.4–1.8 mm in *D. caerulescens*), longer first glumes (0.3–0.8 mm in *D. caerulescens*), leaves 15–20 or more times as long as wide (10–15 times as long in *D. caerulescens*), and usually narrower panicles. *Dichanthelium caerulescens* panicle branches also ascend, but not as strictly as they frequently do in *D. neuranthum*. Both taxa are found in maritime wet grasslands on the Outer Banks of North Carolina.

Plants treated as *Panicum ovinum* Scribn. & J.G. Sm. and found from Arkansas to Mexico are treated here as belonging to *D. neuranthum*. They appear to differ only in having spikelets slightly longer (2.1–2.2 mm) than those found in Atlantic Coastal Plain populations (1.8–2.0 mm long), by distribution, and perhaps by habitat, described as dry or moist open ground, prairies, and swales (Silveus 1942). A population of *D. neuranthum* found June 2009 in a barrens in Union County, North Carolina, belongs to "*P. ovinum*."

Plants from populations in open pine woods in Charlotte and Lee counties, Florida, with spikelets 2.3–2.8 mm long but otherwise resembling *D. neuranthum* were described as *Panicum pinetorum* Swallen. They need additional study, and may be distinct. No populations of *D. neuranthum* with spikelets exceeding 2.2 mm in length have been seen elsewhere.

Distribution and habitat.–Dichanthelium neuranthum occurs locally from North Carolina to Florida, and west to east Texas and Arkansas. It is also found in Mexico, the Bahamas, Cuba, and Belize. Along the Atlantic and Gulf coasts, it is primarily found in maritime wet grasslands and wet pineland savannas near the coast, especially those with a calcareous influence. Plants referable to *Panicum ovinum* occur inland in dry to moist open ground, prairies, and swales from east Texas to Mississippi and Arkansas, and in Mexico, with a disjunct occurrence in the Piedmont of North Carolina.

SECTION **CLANDESTINA**

Dichanthelium cryptanthum (Ashe) LeBlond, comb. nov. BASIONYM: *Panicum cryptanthum* Ashe, North Carolina Agric. Exp. Sta. Bull. 175:115. 1900. *Panicum scabriusculum* Elliott var. *cryptanthum* (Ashe) Gleason, Phytologia 4:21. 1952. TYPE: U.S.A. NORTH CAROLINA. Johnston Co.: swamps at Wilson's Mill, 15 Jul 1897. *Ashe s.n.* (LECTOTYPE: NCU!; ISOLECTOTYPE: NCU!, US!).

Dichanthelium cryptanthum is a distinctive and uncommon to rare witch grass found from New Jersey to Texas. It shares with *D. scabruisculum* (Elliott) Gould & C.A. Clark (sensu stricto) glabrous internodes, a scabrous peduncle, membranous ligules, and ovate-acute spikelets, but differs in several characters. Culms in *D. cryptanthum* are less than 2 mm in diameter above the base while more than 2 mm in *D. scabriusculum*. The lowest nodes are usually retrorsely bearded (glabrous to pubescent in *D. scabriusculum*, or rarely bearded). The ligule is 0.3–0.6 mm long in *D. cryptanthum* and 0.5–1.3 mm long in *D. scabriusculum*. Largest leaves in *D. cryptanthum* are 7–12(–16) cm by 6–9 mm while those of *D. scabriusculum* are 10–25 cm by 8–15 mm. The panicle rachis, branches, and pedicels of *D. cryptanthum* are scabrous and lack pellucid punctations, while these features are smooth and pellucid-punctate in *D. scabriusculum*. Spikelets of *D. cryptanthum* are 2.0–2.4 mm long, compared to 2.1–2.8 mm in *D. scabriusculum*. The first glume in *D. cryptanthum* is 0.7–1.1 mm long, lanceolate, and with a blunt to acute apex. In *D. scabriusculum*, the first glume is 0.3–0.6(–0.8) mm long, reniform to suborbicular (rarely lanceolate), and with a truncate to obtuse apex. *Dichanthelium cryptanthum* resembles a large member of the *D. dichotomum* group and can be mistaken for *D. yadkinense* (Ashe) Mohlenbrock. The latter is readily distinguished by its smooth peduncle and ciliate ligule.

Distribution and habitat.—Dichanthelium cryptanthum occurs locally in the Atlantic and Gulf Coastal

Plain from Virginia to Texas and disjunctly in New Jersey. It is found in a variety of wetland habitats, including small streams, spring heads, seeps, and swamps, especially where the habitat is kept open by fire or repeated disturbance.

SECTION **ENSIFOLIA**

Dichanthelium curtifolium (Nash) LeBlond, comb. nov. BASIONYM: *Panicum curtifolium* Nash, Bull. Torrey Bot. Club 26:569. 1899. *Panicum ensifolium* Baldwin ex Elliott var. *curtifolium* (Nash) Lelong, Brittonia 36:266. 1984. *Dichanthelium ensifolium* (Baldwin ex Elliott) Gould ssp. *curtifolium* (Nash) Freckmann & Lelong, Sida 20:170. 2002. TYPE: U.S.A. MISSISSIPPI. Jackson Co.: Ocean Springs, 2 May 1898, *Tracy 4598* (HOLOTYPE: NY; ISOTYPE: US!).

Panicum austromontanum Ashe, J. Elisha Mitchell Sci. Soc. 16:85. 1900. TYPE: U.S.A. ALABAMA. Jackson Co.: Sand Mountain, Jun 1899, *Ashe s.n.* (LECTOTYPE: US).

Dichanthelium curtifolium has morphological features that appear to link it with two or three sections; this, combined with its restricted and disjunct distribution, may have contributed to conflicting or ambiguous treatments. The bearded nodes suggest a relationship with sections *Dichanthelium* (formerly sect. *Dichotoma*) or *Lanuginosa*, while leaf size, shape, number, and disposition on delicate culms suggest a relationship with sect. *Ensifolia*. The length of the hairy ligule, 1–2 mm, is longer than that of any other taxon in sections *Dichanthelium* and *Ensifolia*, all of which have ciliate ligules at most 1 mm long. The combination of ligule length and spreading sheath pubescence may explain why Gould and Clark (1978) placed *Panicum curtifolium* within their concept of *D. acuminatum* (Sw.) Gould & C.A. Clark var. *implicatum* (Scribn.) Gould & C.A. Clark in sect. *Lanuginosa*. Correll & Johnston (1970) describe *curtifolium* as "basically *P. ensifolium* as to genetic constitution, but contaminated by something like the *P. spretum-P. lindheimeri* complex." Spikelets can be pubescent or glabrous. It is quite possible that *D. curtifolium* is of hybrid origin, but at least some populations occur in distinctive habitats where putative parents are not present.

Plants assigned to *Panicum earlei* Nash were treated in synonymy with *P. curtifolium* by Hitchcock & Chase (1910) and others. The isotype at NCU has glabrous spikelets 1.2–1.3 mm long and bearded nodes, but the internodes as well as sheaths are spreading-hairy and the ligules are 2–2.5 mm long. These plants appear to be more closely related to sect. *Lanuginosa* and are in need of additional study.

Distribution and habitat.—*Dichanthelium curtifolium* ranges sporadically along the Atlantic and Gulf Coastal Plain from South Carolina and Florida west to east Texas and also occurs in the Appalachian Province in North Carolina, Tennessee, and Alabama. It prefers moist shady places and bogs and has been collected in saturated to shallowly inundated streamhead swamps associated with seepage bogs in the Coastal Plain, and in grass-sedge bogs and along mountain streams in the Appalachian Province. Although Hitchcock & Chase (1910, 1950) did not include North Carolina in the distribution of *P. curtifolium*, Hitchcock & Chase (1910) included in synonymy a specimen of *Panicum austromontanum* Ashe "from western North Carolina," and a specimen of *D. curtifolium* was found in Clay Co., NC, in 1956 by H.E. Ahles and A.E. Radford (NCU!).

SECTION **LANCEARIA**

Dichanthelium webberianum (Nash) LeBlond, comb. nov. BASIONYM: *Panicum webberianum* Nash, Bull. Torrey Bot. Club 23:149. 1896. TYPE: U.S.A. FLORIDA. Lake Co.: vicinity of Eustis, 16–31 May 1894, *Nash 781* (ISOTYPE: US!).

Panicum onslowense Ashe, J. Elisha Mitchell Sci. Soc. 16:88. 1900. TYPE: U.S.A. NORTH CAROLINA. Onslow Co.: near Ward's Mill, 19–22 May 1899, *Ashe s.n.* (ISOTYPE: US, fragment). As noted by Hitchcock and Chase (1910), some specimens (e.g., NCU!) distributed as *Panicum onslowense* "and bearing the same data as the type" belong to *Panicum lancearium* Trin.

Dichanthelium webberianum is distinguished from other members of sect. *Lancearia* by its distinctly papillose lemma and palea and larger lower culm and rosette blades. The glabrous culm blades often exceed a centimeter in width, and larger winter rosette blades are 3–8 cm long, compared to 1–2.5(–5) cm in *D. portoricense* sensu lato. Culm internodes are often glabrous (commonly so in the Cape Fear Arch region of the Carolinas) compared to minutely and densely puberulent internodes in other members of the section. *Dichanthelium webberianum* spikelets are longer than those of *D. portoricense* var. *portoricense* (2.1–2.6 mm vs. 1.5–1.8 mm), but

populations of plants in Florida with smooth fertile lemmas and the vegetative characteristics of *D. portoricense* ssp. *patulum* have spikelets up to 2.6 mm long. These include plants referable to *Panicum patentifolium* Nash, which have rosette blades up to 5 cm long but with culm blades no wider than 5 mm. They need additional study.

Distribution and habitat.—D. webberianum occurs locally on the coastal plain from southeastern North Carolina to peninsula Florida. It is found in wet longleaf pine flatwoods and savannas.

LEPTOCHLOA

Leptochloa maritima (E.P. Bicknell) LeBlond & Sorrie, comb. nov. Basionym: *Diplachne maritima* E.P. Bicknell, Bull. Torrey Bot. Club 35:195. 1908. *Leptochloa fascicularis* (Lam.) A. Gray var. *maritima* (E.P. Bicknell) Gleason, Phytologia 4:21. 1952. Type: U.S.A. Massachusetts. Nantucket Co.: sandy shores of Sachacha Pond, 16 Sep 1899, *Bicknell s.n.* (lectotype: NY).

Festuca procumbens Muhl, Descr. Gram. 160. 1817. *Diachroa procumbens* (Muhl.) Nutt., Trans. Amer. Philos. Soc., n.s., 5:147. 1837. *Diplachne procumbens* (Muhl.) Nash, Man. Fl. N. States 128. 1901, nom illeg., non *Diplachne procumbens* Arechav. (1894). Type: U.S.A.: Carolina, *Muhlenberg 235* (holotype: PH).

Leptochloa maritima is distinguished from *L. fascicularis* (Lam.) A. Gray and other members of the *L. fusca* (L.) Kunth complex primarily by its shorter ligules, long-attenuate to awned longer glumes, and longer lemmas and lemma awns. It is specifically distinguished from *L. fascicularis* as follows:

1. Ligules 2–5 mm long; glumes long-attenuate to awned; first glume 2.5–3.5 mm long, second glume 4–7 mm long; lemmas (3–)4–8 mm long; lemma awns (1–)2.5–5 mm long ____ **Leptochloa maritima**
1. Ligules 5–7 mm long; glumes acute, awnless; first glume 1.3–2.7 mm long, second glume 2.2–4.0 mm long; lemmas 2–4 mm long; lemma awns 0.5–1.2 mm long ____ **Leptochloa fascicularis s.s.**

Leptochloa maritima was included in *L. fusca* (L.) Kunth ssp. *fascicularis* (Lam.) N.W. Snow by Snow (2003). He did not recognize entity "*maritima*" "because long [lemma] awns and salinity tolerance are common throughout the species." We find that the combination of characters cited above are consistent throughout the New Hampshire to Florida range. Maximum lemma length in *L. maritima* (8 mm) exceeds the maximum given by Snow for *L. fusca* sensu lato (6 mm). Maximum lemma awn length in *L. maritima* (5 mm) exceeds that given by Snow for his concept of *L. fusca* ssp. *fasciculata* (3.5 mm), as does maximum second glume length for *L. maritima* (7 mm) and *L. fusca* ssp. *fasciculata* (5 mm).

Distribution and habitat: Leptochloa maritima ranges from New Hampshire to Florida. It most frequently occurs on exposed peat and organic muck at or near the coast where vegetation is sparse or of low stature. Habitats include fresh to brackish marshes and overwash flats, edges of tidal creeks, exposed beds of natural and man-made ponds and pools, and interdune wetlands.

THELYPTERIDACEAE

STEGNOGRAMMA

There is an increasing consensus in the pteridological community to accept various long-proposed segregates of *Thelypteris* Schmidel, sensu latissimo. In the southeastern United States, only one member of the segregate genus *Stegnogramma* Blume is present, the remarkable "Alabama shield fern," usually in the past called *Thelypteris pilosa* (M. Martens & Galeotti) Crawford var. *alabamensis* Crawford, and transferred to *Stegnogramma* as *Stegnogramma pilosa* (M. Martens & Galeotti) K. Iwats. var. *alabamensis* (Crawford) K. Iwats.. However, Watkins and Farrar (2002, 2005) make a convincing case for its status as an ancient relictual taxon warranting specific rank, which they established as *Thelypteris burksiorum* J.E. Watkins & D.R. Farrar. Following these recent studies, we accept generic status for *Stegnogramma* and specific rank for the Alabama shield fern, thus necessitating the following new combination.

Stegnogramma burksiorum (J.E. Watkins & D.R. Farrar) Weakley, comb. nov. Basionym: *Thelypteris burksiorum* J.E. Watkins & D.R. Farrar, Amer. Fern J. 92:172 (171–178; figs. 1–4), 2002. Type: U.S.A. Alabama. Winston Co.: in fissures of Pottsville sandstone, on the west fork of Sipsey River 5 mi E of Double Springs, *J.E. Watkins 797* (NY).

Thelypteris pilosa (M. Martens & Galeotti) Crawford var. *alabamensis* Crawford; *Stegnogramma pilosa* (M. Martens & Galeotti) K. Iwats. var. *alabamensis* (Crawford) K. Iwats.

VITACEAE

MUSCADINIA

In the past decade, a number of molecular phylogenetic studies of the Vitaceae have been undertaken, using different genes and different sampling within the family; overall, they all corroborate the clear distinction of the muscadines (scuppernongs) from the true grapes. Some studies suggest that muscadines are sister to *Vitis* L. sensu stricto, while others show equivocal results as to whether *Muscadinia* + *Vitis* is a monophyletic group. Overall, and even if *Muscadinia* is basal to but forms a monophyletic clade with *Vitis* sensu stricto, recognition of *Muscadinia* at generic rank is warranted, based on the long-recognized morphological distinctiveness of *Muscadinia* vs. *Vitis* sensu stricto (tendrils simple vs. bifid or trifid; bark adherent and with prominent lenticels vs. bark shredding and with inconspicuous lenticels; pith continuous through nodes vs. pith interrupted by nodal diaphragms; leaves small, coarsely dentate, and never deeply lobed vs. leaves large, finely serrate, and usually deeply lobed), the genetic distance of it from *Vitis* sensu stricto, the close relationships of taxa within *Vitis* sensu stricto and their rampant interfertility, the different chromosome numbers (40 in *Muscadinia*, 38 in *Vitis* sensu stricto), the frequent past and current recognition of *Muscadinia*, and the standards of morphological distinctiveness of genera in the Vitaceae (Brizicky 1965; Ren et al. 2011; Péros et al 2011; Tröndle et al. 2010; Rossetto et al. 2002; Soejima & Wen 2006).

The classification of muscadine species and lower level taxa has also been variable. For the southeastern United States, Small (1933) recognized 2 species (in *Muscadinia*): *Muscadinia rotundifolia* (Michaux) Small and *M. munsoniana* (J.H. Simpson ex Planch.) Small, and this "two species scheme" has also been employed in *Vitis* as well: *Vitis rotundifolia* Michaux and *V. munsoniana* J.H. Simpson ex Planch. For instance, Correll and Correll (1982) commented that "the larger berries of that species [*V. rotundifolia*], however, with their tough thick skin and musky sweet pulp are strikingly different from those of our species [*V. munsoniana*]." On the other extreme, Wunderlin and Hansen (2011) lump *V. munsoniana* into *V. rotundifolia* without varietal status or comment. Moore (1988) commented that the "characters used to distinguish *V. munsoniana* from *V. rotundifolia*, particularly leaf size, appear to intergrade abundantly, making assignment of intermediate individuals to one species or the other most difficult." In 1991, Moore followed this up by treating the "*munsoniana* entity" at varietal rank and making the new combination necessary to do so (Moore 1991).

Our perception is that these two entities are easily distinguished in the core of their distributions ("*rotundifolia*" in most of the southeastern United States, "*munsoniana*" in southern Florida and the Bahamas), but that in northern Florida and adjacent southern Georgia and southern Alabama a rather broad zone of intermediate and difficult-to-place material is encountered, as noted by Moore (1988, 1991). This fits with our concept of entities that should be recognized at varietal rank. In addition, Ward (2006) makes a persuasive case that an additional entity, previously studied and recognized but not formally named, is another narrowly endemic taxon of the scrub of the Florida central ridge: *Vitis rotundifolia* Michx. var. *pygmaea* McFarlin ex D.B. Ward.

The only other taxon of muscadine is *Vitis popenoei* J.L. Fennell of southern Mexico and northern Central America; its differences in morphology and distribution support its specific distinction from the taxa of the southeastern United States and West Indian discussed above. In order to accommodate the treatment of muscadines as warranting generic status as the genus *Muscadinia*, and the distinction of "*munsoniana*" and "*rotundifolia*" at varietal rank in *Muscadinia*, we make the following combinations.

Muscadinia rotundifolia (Michx.) Small var. **munsoniana** (J.H. Simpson ex Planch.) Weakley & Gandhi, comb. et stat. nov. Basionym: *Vitis munsoniana* J.H. Simpson ex Planch. in A.L.P.P. de Candolle & A.C.P. de Candolle, Monogr. Phan. 5:615. 1887. *Vitis rotundifolia* Michx. var. *munsoniana* (J.H. Simpson ex Planch.) M.O. Moore; *Muscadinia munsoniana* (J.H. Simpson ex Planch.) Small. Type: U.S.A. Florida. Manatee Co.: collected along Manatee River, 1883, 1885, 1887, *J.H. Simpson*, cultivated Munson vineyard, Denison, Texas, 1890. [lectotype, designated by M.O. Moore (1991): PH].

Muscadinia rotundifolia (Michx.) Small var. **pygmaea** (McFarlin ex D.B. Ward) Weakley & Gandhi, comb. nov. Basionym: *Vitis rotundifolia* Michx. var. *pygmaea* McFarlin ex D.B. Ward, Phytologia 88:219. 2006.Type: UNITED STATES. Florida. Highlands Co.: sand dunes, Lake Jackson, Sebring, *J.B. McFarlin* 5707, 9 Jun 1931 ["flowers"] (holotype: US 1728170). Paratypes: FLORIDA. Highlands Co.: sand dunes, Lake Jackson, Sebring, *J.B. McFarlin* 6524, 15 Aug 1931 ["fruits"] (US 1728171).

Muscadinia popenoei (J.L. Fennell) Weakley & Gandhi, comb. nov. BASIONYM: *Vitis popenoei* J.L. Fennell, J. Wash. Acad. Sci. 30:17, fig. 2, 1940.

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BOOK REVIEW

Simon Gilroy and Patrick H. Masson (eds.). 2008. **Plant Tropisms.** (ISBN-13: 978-0-8138-2323-2, hbk.). Blackwell Publishing Professional, 2121 State Avenue, Ames, Iowa 50014, U.S.A. (**Orders:** 1-800-862-6657, http://www.wiley.com/WileyCDA/WileyTitle/productCd-0813823234.html). $230.00, 240 pp., 7" × 10".

From the Publisher: "Plants, as sessile organisms, spend their entire lives at the site of seed germination. To survive the very diverse stresses they will inevitably encounter, plants require a suite of strategies to respond to their environments. One key adaptation is the ability of most plant organs to grow in directions that are dictated by specific cues, such as light, gravity, touch, gradients in humidity, ions, oxygen, and temperature. This directional growth, or tropism, is believed to significantly contribute to plant survival.

Plant Tropisms reviews current research in this rapidly growing field. Chapters look at physiological, molecular, and cell biological processes that underlie plant tropisms. *Plant Tropisms* tracks the evolution of our conception of tropisms from simple laboratory curiosities to becoming important tools with which to decipher basic biological processes that are essential to plant growth and development in a variety of environments.

Plant Tropisms will provide a comprehensive, yet integrated, volume of the current state of knowledge on the processes that govern tropisms. This volume will be great use to researchers and professionals interested in plant molecular biology, cell biology, growth and development, and plant adaptation."—*Gary L. Jennings, Librarian, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

A FOSSIL FLOWER OF *PERSEA* (LAURACEAE) IN TERTIARY DOMINICAN AMBER

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ABSTRACT

Persea avita sp. nov. is described from a flower in Tertiary Dominican amber. The absence, through post-anthesis loss, of 2 of the 3 large, inner tepals of the fossil allows an interior view of the remaining fertile stamens and developing ovary. If correctly placed in *Persea*, the species probably belongs to subgen. *Eriodaphne*, sect. *Aurataea*, in which the 3 outer tepals are smaller than the inner, the ovary is pubescent, and the fertile stamens are 9 in number. In the fossil, 2 of the staminodia of Series IV are apparently missing, having been lost along with the 2 absent tepals of the inner whorl and their associated Series II stamens. The 11 species of sect. *Aurataea* are presently limited to South America (Kopp 1966).

RESUMEN

Persea avita sp. nov. se describe de una flor el ámbar Terciario Dominicano. La ausencia, por pérdida post-antesis, de 2 de los 3 tépalos grandes internos del fósil permite una vista del interior con los estambres fértiles que permanecen y el ovario en desarrollo. De estar correctamente colocado en *Persea*, la especie probablemente pertenece al subgen. *Eriodaphne*, sect. *Aurataea*, en la que los 3 tépalos externos son más pequeños que los internos, el ovario es pubescente, y los estambres fertiles son 9. En el fósil, 2 de los estaminodios de la serie IV están perdidos aparentemente, habiéndose perdido junto con los 2 tepalos ausentes del verticilo interno y su Serie II de estambres asociada. Las 11 especies de la sect. *Aurataea* están limitados actualmente a Sur America (Kopp 1966).

INTRODUCTION

Remains of organisms found embedded in amber include animals, especially terrestrial invertebrates, and plant parts, such as flowers, pollen, leaves, bryophyte stems, and wood fragments (Poinar 1992; Poinar & Poinar 1999). The preservation of flowers in three-dimensional form may allow their assignment to modern genera (Poinar et al. 2008a, revised by Chambers & Poinar 2010; Chambers et al. 2011) or to novel genera of either verifiable or uncertain affinity (Conwentz 1886; Poinar & Chambers 2005; Poinar et al. 2008b; Chambers et al. 2010). The majority of described amber flowers are from Baltic deposits (Spahr 1993), but the above-cited reports include both Mid-Tertiary Dominican amber and Early Cretaceous Burmese amber.

In an ongoing investigation of Dominican amber, we discovered a flower that is clearly referable to family Lauraceae. Despite its being past anthesis and not in prime condition, it retains a combination of features that favors an assignment to the genus *Persea*, with affinity to species of sect. *Aurataea*. In consideration of its Mid-Tertiary age and its occurrence outside the South America range of the section, we propose its description under the new name *Persea avita*.

MATERIALS AND METHODS

The fossil originated from mines in the northern mountain range (Cordillera Septentrional) of the Dominican Republic, between the cities of Puerto Plata and Santiago. Dating of Dominican amber is controversial, with a youngest proposed age of 20–15 mybp based on foraminifera (Iturralde-Vinent & McPhee 1996) and an oldest

of 45–30 mybp based on coccoliths (Cêpek in Schlee 1999). Most of the amber is secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994).

DESCRIPTION

Persea avita K.L. Chambers, Poinar, & A.E. Brown, sp. nov. (**Figs. 1–6**). Type: HISPANIOLA. Dominican Republic: amber mine in the northern mountain ranges (Cordillera Septentrional). 1995, *unknown amber miner* s.n. (HOLOTYPE: catalogue number Sd-9-180, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

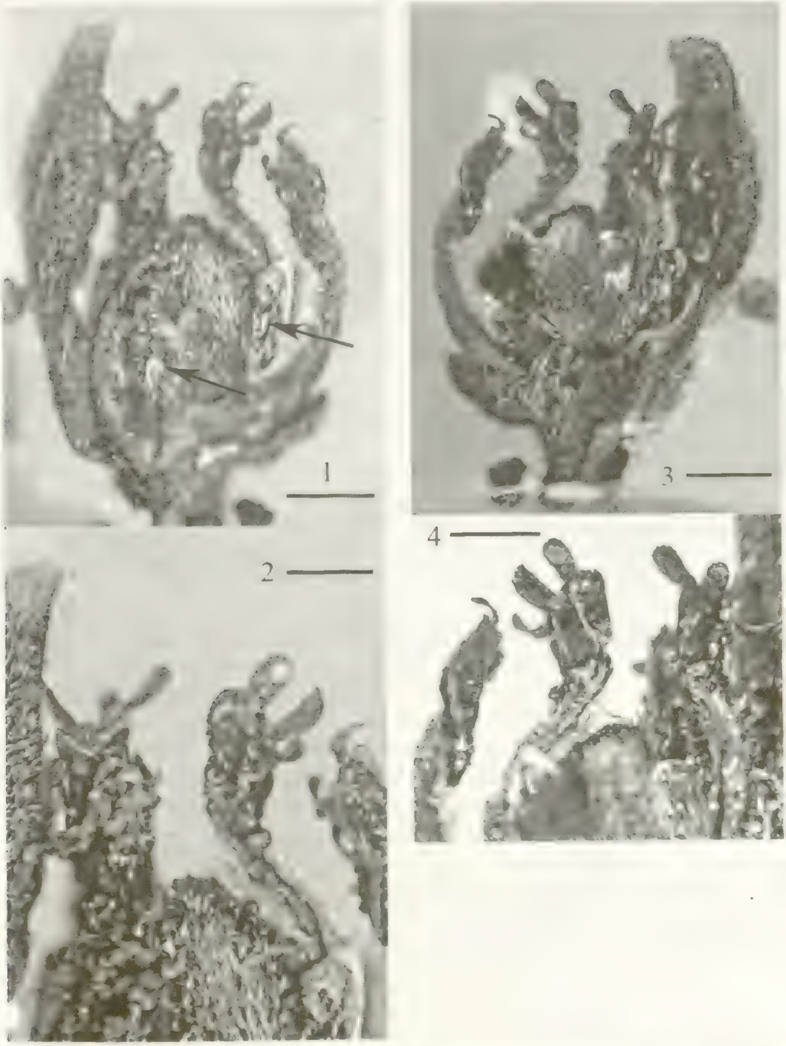
Flower perfect, post-anthesis, remaining pedicel 0.53 mm, not swollen, receptacle flat, hypanthium (cupule) none, perianth parts originally 6 (2 inner tepals missing), outer tepals ovate-deltoid, 1 mm long, densely strigose abaxially (adaxial side not visible), remaining inner tepal 4.3 mm long, elliptic-lanceolate, densely strigose ad- and abaxially, fertile stamens originally 9 in 3 series (6 stamens remaining: 1 first-whorl stamen represented only by a basal filament stub, 2 stamens of second whorl completely missing), filaments 1.3–2.0 mm long, linear, curved adaxially, densely puberulent, short-stalked, basally-attached, glands present on third-whorl stamens, glandular portion 0.8–1.0 mm (Fig. 1), anthers 0.8–1.1 mm, originally 4-locular (some pollen sacs possibly merged before or after anthesis), remaining valves uplifted distally or laterally, anthers of Series I and II introrse, of Series III latrorse or extrorse, staminodia of innermost series assumed to be 3 (2 missing, 1 not in observable position), developing ovary superior, 1.7 mm long, 0.9 mm wide, densely strigose, style deciduous.

Etymology.—from the Greek "avitus," ancestral, grandfatherly.

DISCUSSION

The flower is post-anthesis, as evidenced by the developing ovary and loss of some tepals, stamens, glands, and staminodes. The remaining stamens are 2 of Series I, 1 of Series II, and 3 of Series III. Two of the anthers appear to have just 2 large anther sacs, but this may be due to confluence of the paired locules. Four of the 6 basal glands on the Series III stamens can be seen. While no Series IV staminodes are visible, our assumption is that 2 have been lost in conjunction with the loss of their associated large tepals and Series II stamens, but that the third may be present, although hidden by its adjacent Series III fertile stamens. It is not obvious whether the absent floral parts were naturally dehiscent or were removed by insect predation; however, we favor the latter possibility. Our suggested placement of the flower in subgen. *Eriodaphne* requires that the perianth parts be persistent rather than deciduous (van der Werff 2002). The New World genera *Aniba* and *Aiouea*, with Series IV staminodia inconspicuous or absent, differ from the fossil in their 2-loculed anthers (Kubitzki 1982; Renner 1982). There are several Old World genera that lack such staminodia, as described by Pax (1891) and Rohwer (1993), but we excluded them as possible congeners of this New World amber species. To identify possible extant relatives of the fossil, we reviewed the New World genera listed by these authors, as well as the annotated list of genera in Little (2006, tab. 5.1). The fossil is well accommodated in *Persea* sect. *Aurataea* with respect to the pubescence of its tepals, filaments, and ovary (Kopp 1966), as well as its comparatively small outer tepals. The length and shape of the filaments and anthers, the number and arrangement of anther locules, the directions of anther dehiscence, and the absence of a receptacular cupule are typical of this genus, as well (Allen 1945, 1948; van der Werff 1991).

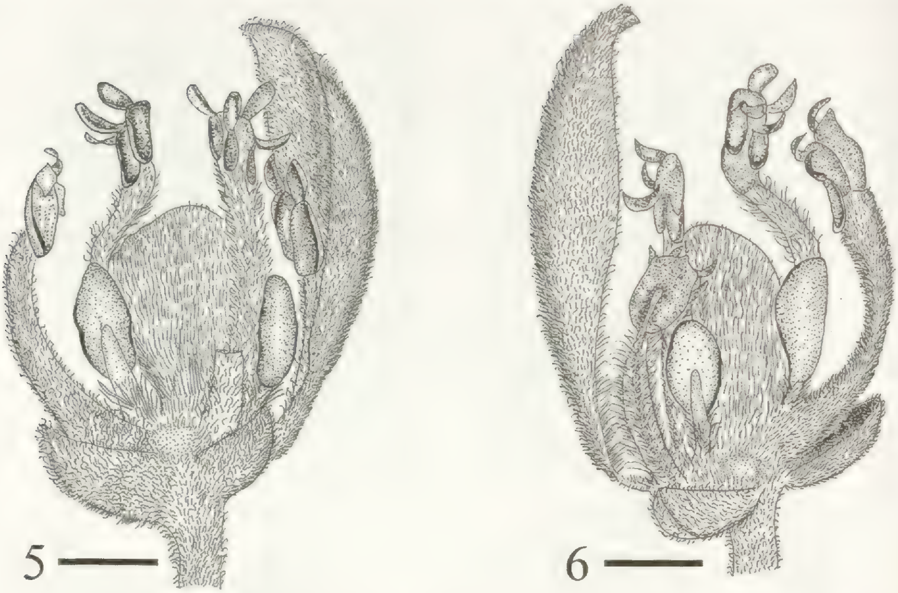
The possibility of an alternative placement was suggested by H. van der Werff (pers. comm.), involving *Corydodaphnopsis*, a genus once known only from southeast Asia (Kostermans 1974) but later identified also from Central and South America (van der Werff & Richter 1985; van der Werff 1986; Zamora et al. 1988). Identification of this genus is principally by the vegetative features of opposite leaves and details of wood anatomy (van der Werff & Richter 1985; Zamora et al. 1988), the interspecific variation in some floral characteristics making generic characterization difficult. This applies especially to the anthers, which may have only two pores or, if four pores, then these are arranged either in an arc or in pairs, one above the other. The filaments are characteristically no longer than the anthers, but in the New World species *C. fosteri* and *C. burgeri*



FIGS. 1–4. *Persea avita*. 1. Side 1 of flower. Arrows indicate glands of Series III stamens. Scale bar = 0.70 mm. 2. Enlarged view of anthers, ovary, and gland of Side 1. Scale bar = 0.56 mm. *Persea avita*. 3. Side 2 of flower. Air bubble occupies split in ovary wall, gland of Series III stamen on left obscured by extraneous particle in amber. Scale bar = 0.75 mm. 4. Enlarged view of anthers and ovary apex of Side 2. Scale bar = 0.73 mm.

they are 2–4 times the anther length. The ovary is usually glabrous (Kostermans 1974), but it is pubescent in *C. fosteri* and *C. burgeri* (van der Werff 1986; Zamora et al. 1988). The staminodes, except in *C. burgeri*, are short-stalked, and the glands of the Series III stamens are relatively large. A similarity between this genus and the Dominican fossil is the relatively small outer tepals, a trait also seen in *Persea*, as in *P. nivea* of section *Aurataea* (Kopp 1966, fig. 9).

Given that we have no access to the critical vegetative features mentioned above, the variability in floral characteristics of *Corydodaphnopsis* make an assignment to that genus too uncertain, in our opinion, but attention can be called to the fossil's similarity in perianth, stamens, and ovary to certain New World species, especially *C. burgeri* of Costa Rica.



FIGS. 5–6. ***Persea avita*. 5. Reconstructive drawing of Side 2. Air bubble removed to show complete ovary. Scale bar = 0.73 mm. 6. Reconstructive drawing of Side 1. Scale bar = 0.70 mm.**

The Lauraceae have a long fossil history, with clearly identified Cretaceous floral remains dating from the Early Albian, Cenomanian, and Turonian (Drinnan et al. 1990; Herendeen et al. 1994; Eklund 2000; Friis et al. 2006; von Balthazar et al. 2007). A summary of Tertiary Lauraceae fossils recorded from the North American Plate was given by Taylor (1988), in conjunction with the description of Middle to Upper Eocene *Androglandula* of tribe *Cinnamomeae*. An unpublished genus of Lauraceae from the Middle Eocene of British Columbia was described by Little (2006) and illustrated (Little et al. 2009), with emphasis on fruit anatomy and development. The fossil lacks staminodia and differs from ours in having large outer tepals, bilocular stamens, and a glabrous ovary. A molecular clock analysis of the family was attempted by Chanderbali et al. (2001). The best resolution for a selected group of species of the tribes *Perseeae* and *Laureae* (in the sense of Rohwer 1993) was provided by the ITS/5.8S region of nrDNA. This showed a date of 45 mybp for the separation of the *Persea* subgroup (3 species of *Persea* and 1 of *Apollonias* sampled) from a clade joining the *Ocotea* subgroup and tribe *Laureae*. The approximate age of the Dominican amber, 20–30 mybp, is thus in accord with a Mid-Tertiary evolution of *Persea*, based on this single-gene estimation of molecular clock dating. To the best of our knowledge, the present specimen is the first fossil record for this genus.

A molecular phylogenetic study of Lauraceae by Rohwer (2000), using the cpDNA *matK* gene, confirmed that the *Persea* group of genera (a sample of *Persea*, *Apollonias*, *Alseodaphne*, and *Dehaasia*) is monophyletic. More recently (Rohwer et al. 2009), a phylogenetic study based on nrDNA ITS sequences in a sample of 61 species of the *Persea* group, raised the possibility that *Persea* itself, as currently delimited, is polyphyletic. Species of subgen. *Eriodaphne* are in a clade separate from that containing members of subgen. *Persea*. The authors suggest that subgen. *Eriodaphne* will ultimately have to be treated taxonomically as the separate genus *Mutisiopersea*, should this cladistic relationship be confirmed by later molecular analyses. However, separate generic status for subgen. *Eriodaphne* is not supported by the results of Li et al. (2011), based on molecular phylogenetic analysis of the combination of ITS and *LEAFY* intron II.

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TWO FOSSIL FLOWERS OF *TRICHILIA* (MELIACEAE) IN DOMINICAN AMBER

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ABSTRACT

Mid-Tertiary amber from the Caribbean island of Hispaniola has yielded flowers of several eudicot species characteristic of tropical and subtropical forests of that time period. We here describe as new species two recently discovered Dominican amber flowers, which we assign to *Trichilia*, the largest genus of Meliaceae in the neotropics (Pennington et al. 1981). Both flowers possess features that frequently occur in the genus, such as a dish- or cup-shaped calyx, spreading or recurved petals, and completely fused filaments forming a cylindrical or cyathiform tube that bears acute or apiculate lobes alternating with the anthers on the rim. One flower is complete, with pistil and anthers present, while on the second, the pistil and all but one anther have been damaged or removed by insect predation. The one remaining anther is malformed and non-functional; the filament tube appears to be filled with debris left by the putative insect herbivore. The two fossils differ in their calyx shape and pubescence, corolla pubescence, and filament tube shape, and are described as the new species **Trichilia glaesaria** and **Trichilia antiqua.**

RESUMEN

El ámbar del Terciario medio de la isla caribeña de la Hispaniola ha aportado flores de varias especies de eudicotiledoneas caracteristicas de bosques tropicales y subtropicales de aquel periodo de tiempo. Describimos aquí como nuevas especies dos flores descubiertas recientemente en el ámbar dominicano, que asignamos a *Trichilia*, el mayor género de Meliaceae en el neotrópico (Pennington et al. 1981). Ambas flores tienen caracteristicas que ocurren frecuentemente en el genero, tales como un caliz en forma de plato o taza, petalos extendidos o recurvados, y filamentos completamente fusionados formando un tubo cilíndrico o ciatiforme que tiene lóbulos agudos o apiculados alternando con las anteras en el borde. Una flor esta completa, con pistilo y anteras presentes, pero en la segunda, el pistilo y el resto excepto una antera han sido dañados o quitados por predación de insectos. La unica antera que queda está mal formada y no es funcional; el tubo de los filamentos parece estar lleno de restos dejados por el putativo insecto herbívoro. Los dos fósiles difieren en la forma del caliz y su pubescencia, pubescencia de la corola, y forma del tubo de los filamentos, y se describen como las nuevas especies **Trichilia glaesaria** y **Trichilia antiqua.**

INTRODUCTION

A reconstruction of the Late Oligocene/Early Miocene tropical forests of Hispaniola was provided by Poinar & Poinar (1999), based on fossil plant and animal remains in amber derived from resin of the arborescent legume *Hymenaea protera*. Novel taxa recently described from flowers found in these deposits include species of *Licania* (Chrysobalanaceae) (Poinar et al. 2008a, revised by Chambers & Poinar 2010), *Persea* (Lauraceae) (Chambers et al. 2011), and *Trochanthera* (possibly Moraceae) (Poinar et al. 2008b). The flowers newly reported here are referable to Meliaceae, a large and commercially important family found throughout the Old and New World tropics and subtropics, but also penetrating into temperate zones. Although on one flower the pistil, one petal, and most of the anthers are missing, very likely through the predation of an insect, we believe the flower structure of both fossils, in particular the characteristic filament tube with sharply pointed lobes between the anthers, point to their placement in *Trichilia* P. Browne. We here propose their description as the new species *Trichilia glaesaria* and *Trichilia antiqua*.

MATERIALS AND METHODS

The fossils originated from mines in the Cordillera Septentrional of the Dominican Republic, between the cities of Puerto Plata and Santiago. Dating of these amber deposits is controversial, with a youngest proposed age of 20–15 mybp, based on foraminifera (Iturralde-Vinent & McPhee 1996) and an oldest of 45–30 mybp based on coccoliths (Cêpek in Schlee 1999). Most of the amber is secondarily deposited in turbiditic sandstones of the Upper Eocene to Lower Miocene Mamey Group (Draper et al. 1994).

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DESCRIPTIONS

Trichilia glaesaria K.L. Chambers, Poinar, & A.E. Brown, sp. nov. (**Figs. 1–2**). TYPE: HISPANIOLA. DOMINICAN REPUBLIC: amber mine in the northern mountain range (Cordillera Septentrional), 1995, *unknown miner s.n.* (HOLOTYPE: catalogue number Sd-9-27B, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Flower pistillate, total length 4.5 mm; calyx abaxially strigillose, 0.8 mm long, shallowly cup-shaped, with distinct, broadly acute lobes 0.45 mm long (Fig. 2), petals 5, free, valvate, lanceolate, acute, with incurved tip, spreading to revolute, 3.4 mm long, 1.5 mm wide, adaxial surface densely low-papillate, abaxial surface strigillose, filament tube cyathiform, glabrous, 1.8 mm long, 3.3 mm wide (Fig. 1), anthers 10, sterile, sessile, lanceolate, glabrous, 0.7–0.9 mm long, anther sacs narrow, indehiscent [or dehisced and empty on some anthers, (Fig. 1)], rim of filament tube with acute lobes between anthers, placement of anthers alternating slightly higher and lower, pistil present, style equaling anther tube in length, stigma capitate, minutely papillose, ovary strigillose.

Etymology.—from the Latin "glaesarius," of amber.

Trichilia antiqua K.L. Chambers, Poinar, & A.E. Brown, sp. nov. (**Figs. 3–5**). TYPE: HISPANIOLA. DOMINICAN REPUBLIC: amber mine in the northern mountain range (Cordillera Septentrional), 1995, *unknown amber miner s.n.* (HOLOTYPE: catalogue number Sd-9-27A, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Functional gender of flower uncertain, total length 3.4 mm; calyx glabrous, rotate, ca. 0.8 mm long (Fig. 4), no lobes evident, remaining petals 5 of 6, free, valvate, lanceolate, acute, strongly recurved, 2.6 mm long, 0.7 mm wide, adaxial and abaxial surfaces densely low-papillate, filament tube cylindrical, glabrous, 1.8 mm long, 1.6 mm wide (Fig. 3), remaining anther 1 of 10, sterile, glabrous, subsessile, globose, diameter 0.47 mm (Fig. 5), rim of filament tube with acuminate lobes 0.4 mm long alternating with basal stubs of 9 missing anthers, alternate anthers positioned lower on the rim (Fig. 3), pistil apparently damaged due to insect predation.

Etymology.—from the Latin "antiquus," old.

DISCUSSION

The two species, perhaps contemporaneous in the same Mid-Tertiary amber deposit on Hispaniola, are distinguishable by several floral characteristics. Differences are seen in the pubescence of the abaxial surfaces of the calyx and petals, in the shape and lobing of the calyces, and in the shape of the filament tubes and depth of placement of the lower versus higher anthers on the rim. Minor differences are the incurved petal tips in *Trichilia glaesaria*, which seem not to be as prominent in *T. antiqua*, the sessile anthers of the first species versus the short remaining filament in the second (Fig. 5), and the acute versus acuminate lobes of the staminal tube (Figs. 1, 3).

As previously indicated, the flower of *Trichilia antiqua* shows damage to its reproductive organs, which we believe may be due to an insect feeding inside the filament tube on the pistil, devouring most of the anthers, and removing one petal. The single small and malformed anther on the holotype seems to be a developmental abnormality, rather than the result of insect damage. The ovary of a partly damaged pistil can be seen well down in the filament tube. The absence of normal anthers and pistil prevent us from assigning a gender to this flower. The perianth parts, filament tubes, and anther arrangement of both fossils favor their chosen assignment to *Trichilia*. The alternation of sharply pointed lobes with the sessile or subsessile anthers on the rim of the staminal tube in both species is characteristic of many neotropical taxa of this genus (Pennington & Styles 1975, Pennington et al. 1981). Also, the placement of the anthers in higher and lower positions on the rim of the tube is found in some *Trichilia* species, for example *T. appendiculata* (Triana and Planch.) C. DC. and *T. magnifoliola* Pennington (Pennington et al. 1981). Adaxially papillose petals are found in *T. glabra* L., *T. claussenii* C. DC., *T. pallida* Swartz, and *T. pittieri* C. DC., among others, while abaxially strigillose calyx, petals, and ovary are common in New World species of the genus (Pennington et al. 1981).

Due to the Mid-Tertiary age of the two holotypes, and to the lack of information on critical features of their vegetative habit and male flowers, we favor their description as novel species rather than proposing an

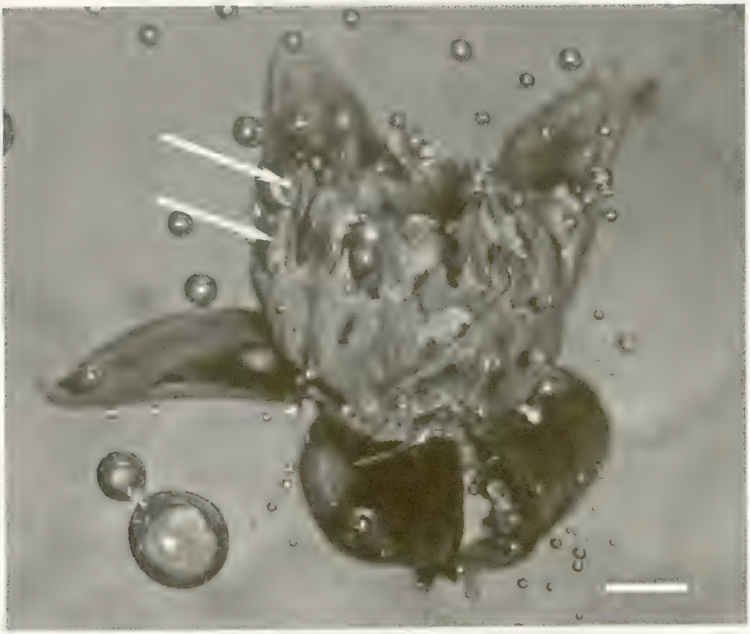

FIG. 1. *Trichilia glaesaria*. Flower in lateral view, showing alternating anthers and acute lobes on rim of filament tube. Note incurved tip of petal and capitate stigma visible within filament tube. Arrows indicate dehisced, empty anther sacs. Bar = 0.8 mm.

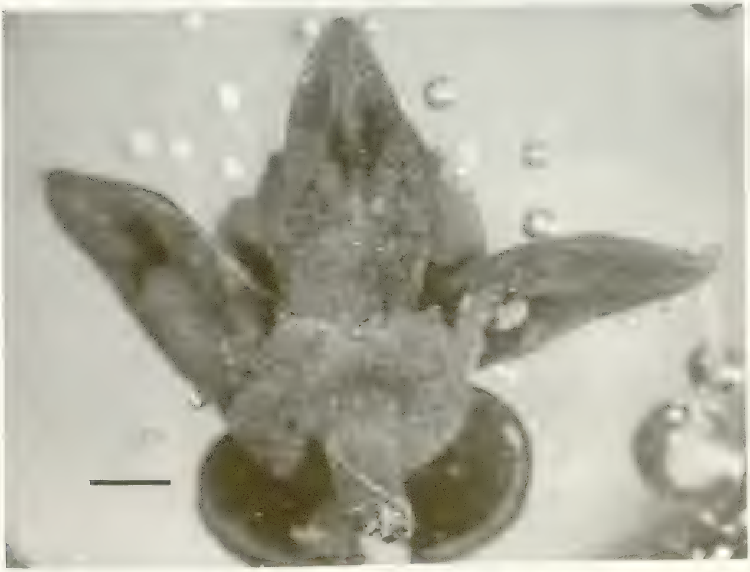

FIG. 2. *Trichilia glaesaria*. Basal view of flower, showing shallowly lobed calyx and abaxially strigillose petals and calyx. Bar = 0.8 mm.

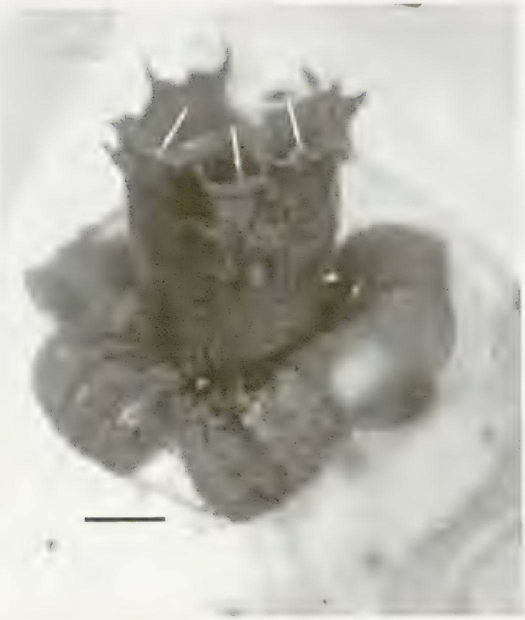

Fig. 3. *Trichilia antiqua*. Flower in lateral view. Arrows indicate basal stubs of missing anthers alternating with acuminate lobes at two heights on rim of filament tube. Bar = 0.6 mm.

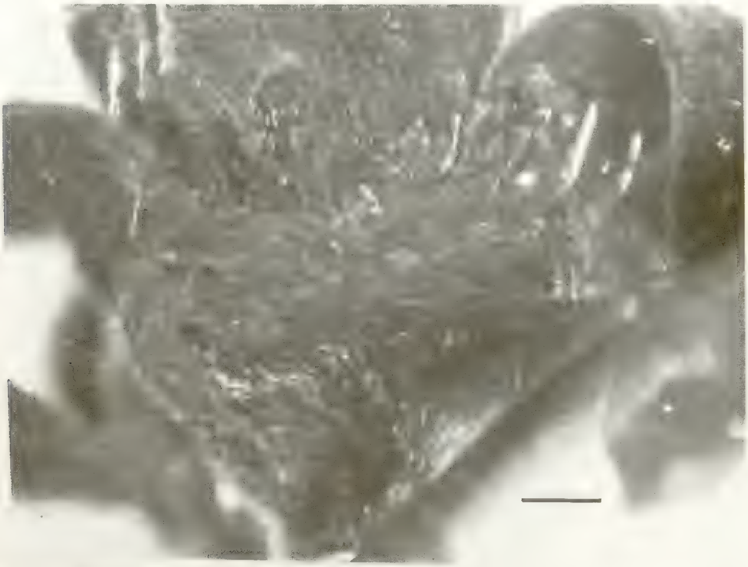

Fig. 4. *Trichilia antiqua*. Lateral view of base of flower, with rotate, glabrous calyx and scar of missing petal. Bar = 0.2 mm.

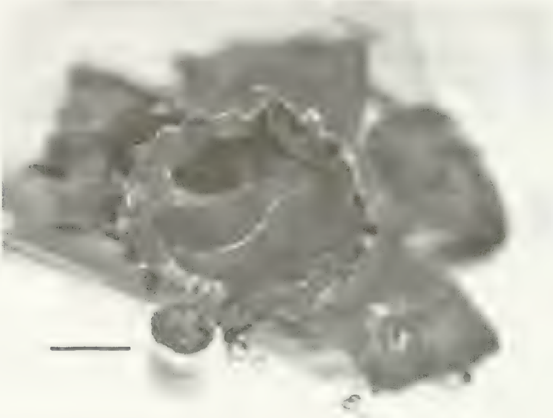

Fig. 5. *Trichilia antiqua*. Apical view of flower, showing rim of filament tube with remnant of abnormally developed anther. Anther tube obscured by debris from possible insect herbivore. Bar = 0.6 mm.

uncertain placement in particular extant species of this large and diverse genus (Pennington & Styles 1975). The critical differences between the two fossils are in the shape and pubescence of the calyx and the abaxial pubescence of the corolla. The relatively cup-shaped staminal tube of *T. glaesaria* versus the cylindrical one of *T. antiqua* might suggest only intraspecific variability, as for example in the difference between staminate and pistillate flowers in *T. moschata* Swartz, as illustrated by Pennington et al. (1981, p. 194). Variation in calyx shape and pubescence also occurs in some modern species, e.g. *T. schomburgkii* C. DC. (Pennington et al. 1981, pp. 162–167), in which the calyx may be "patelliform with 4–5 broadly ovate or triangular lobes…or [the] margin ± truncate, sparsely minutely puberulous or glabrate." As we have only the two examples at hand and cannot examine species variability, we have chosen to describe them as separate taxa, hoping this will assist in their comparison with modern species of Central and South America.

The fossil record of *Trichilia* is limited to a report from the Lower Miocene palynoflora of Cameroon ascribed to this genus (Salard-Cheboldaeff 1978, pollen named as *Psilastephanocolporites* [sic!] *grandis* n. sp.). In a paper by Muellner et al. (2006), this and other Meliaceae fossils, together with chloroplast DNA data, are the basis for estimates of divergence times in the family. The *rbcL* DNA cladogram presented by these authors includes a monophyletic clade of *Trichilia* and 11 other genera, which is assigned an origin in the Oligocene. Apart from *Trichilia*, members of this clade are presently limited to the Old World tropics, from Africa to Madagascar, India, Indo-China, Malesia, and Austroasia. Muellner et al. (2006) propose a West Gondwanan Cretaceous origin for the Meliaceae, with dispersal across Eurasia and between Eurasia and North America provided by the Beringian and North Atlantic land bridges, thence extending from North to South America via island chains or direct land connections during the Tertiary (cf. Muellner et al. 2010, with a dense sampling of Cedreleae). The age of the Dominican fossils is commensurate with the Oligocene crown age of the clade comprising *Trichilia* and relatives (Muellner et al. 2006). Concerning the crown group age of the modern genus *Trichilia*, however, the chronograms of Muellner et al. (2006, 2007) suggest a Miocene origin.

The placement of *Trichilia* in subfamily Melioideae (Harms 1940) has been confirmed by the DNA phylogenetic research (Muellner et al. 2003, 2007, 2008). However, the tribe Trichilieae, based on this genus, was resolved as non-monophyletic in the latter study (Muellner et al. 2008). Although Harms (1940) had divided *Trichilia* into 10 sections, only 5 of these comprise the genus in its modern circumscription, according to Pennington et al. (1981), and these authors go further in reducing the recognized sections to only two: Sect. *Trichilia* and Sect. *Moschoxylum* C. DC. Within *Trichilia*, the new species belong to the emended Sect. *Moschoxylum*, the defining traits being the valvate petals and completely united filaments.

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We thank Terence Pennington for his useful comments regarding possible taxonomic affinities of *T. antiqua*. Much help was provided by Alexandra Muellner and an anonymous reviewer, especially in our interpretation of the distributional history and chronological dating of the clade based on *Trichilia* and allied genera.

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NOTE ABOUT THE TAXONOMY OF *PHASEOLUS HYGROPHILUS* DEBOUCK (LEGUMINOSAE-PAPILIONOIDEAE)

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In relation to Article 8 of the International Code of Botanical Nomenclature (McNeill et al. 2006)— that states "For the purpose of typification a specimen is a gathering, or part of a gathering, of a single species or infraspecific taxon made at one time ..."—about a *Phaseolus* bean species described recently (Salcedo-Castaño et al. 2011), it might be useful to indicate the following. The text on top of page 54 of the aforementioned paper (Salcedo-Castaño et al., *ibidem*) should read as follows (while the rest of text remains unchanged).

Phaseolus hygrophilus Debouck, sp. nov. (**Figs. 1–6**). Type: COSTA RICA. San José: San Isidro El General, Santa Eduviges, on path to Santa Eduviges 8.8 km from intersection at División with Interamerican Highway, Long. 83°45'W, Lat. 9°30'N, alt. 1,520 masl, 11 Dec 2003, *DG Debouck & R Araya Villalobos 3172* (holotype: INB; isotypes: BRIT, CR, F, FI, G, GH, K, MEXU, MICH, NY, P, UC, USJ; in addition, small amounts of seeds, accessioned as G40815, can be obtained from the Genetic Resources Program of CIAT).

Haec species *Phaseolo oligospermo* similis, sed ab eo foliolis non lobulatis ad centrum variegatis, inflorescentiae bracteis primariis cupulatis, bracteolis rotundatis mayoribus alisque albidis cum vexillo subroseo distinguitur. Crescit in sylvis pluvialis montium declivitatis Pacificae Costa Ricae ad 1,500 m supra mare rarus.

Two of the authors (DGD and RAV) had later the opportunity to revisit the type locality and to see the same plant population again on 11 February 2004 and on 19 January 2006 at the same spot. Similarly, the second population of *P. hygrophilus* (DGD & RAV 3173) initially found on 11 December 2003 was again seen on 19 January 2006. These findings indicate first that this rare bean plant can be identified unequivocally over time, and second that during that period these populations of *P. hygrophilus* were stable in an intact original environment.

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BOOK REVIEW

ERNEST SMALL. 2009. **Top 100 Food Plants.** ISBN-10: 0660198584, ISBN-13: 9780660198583, pbk.). NRC Research Press, 1200 Montreal Road, M-58, Ottawa, Ontario, K1A OR6, CANADA. (**Orders:** phone 1-877-672-2672, info@nrc-cnrc.gc.ca). $34.95, 656 pp., 250 illustrations, 8½" × 11".

This book reviews scientific and technological information about the major food plants and their culinary uses. It is illustrated with black and white photographs and more than 250 illustrations from the masterpieces from the golden age of botanical illustration as well as contemporary illustrations. Most of the book consists of 100 chapters dealing with one of the food crops, either a specific species or a group of species. Each chapter follows the same format. An initial section entitled "Names," a "Plant Portrait," "Culinary Portrait," "Curiosities of Science and Technology," and finally "Key Information Sources" which includes a subsection entitled "Specialty Cookbooks." There are more than 3,000 literature citations in the book. I particularly appreciate having the citations included with the species that is being discussed rather than having to wade through a comprehensive listing which could be a tad confusing with as many sources that have been cited in this book. Another nice touch is the inclusion of the "Specialty Cookbooks" subsection in the main body of the work. Not everyone is a cook so it is easy to read right over it but if you are a cook then it is there to be devoured and to be used.

All categories of food plants are covered and information is provided on scientific and common names, appearance, history, economic and social importance, and food uses, including practical information on storage and preparation. The book is intended to be a reference guide for specialists in agricultural areas, with thousands of literature citations backing up the information provided. However, the general public should also find this volume appealing, because of the hundreds of attractive illustrations included, and the huge interest today in the subjects of gardening, cooking, and human health in relation to diet. The author received the Land Anderson Award in 2009 for this title published in Canada.—*Gary L. Jennings, Librarian, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

SALVIA CARRILLOI (LAMIACEAE), A NEW SPECIES FROM GUATEMALA

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ABSTRACT

Salvia carrilloi is a new herbaceous species described from the Western highlands of Guatemala. This taxon resembles *Salvia tortuosa* Kunth but differs in having magenta corolla lobes and a white corolla tube. and verticillasters with 9–16 flowers.

RESUMEN

Se describe la especie nueva **Salvia carrilloi** de los regiones montañosas del oeste de Guatemala. La especie nueva se asemeja a *Saliva tortuosa* Kunth pero difiere de ésta por tener la corola con el tubo blanco y los lobulos de color magenta, y verticilastros con 9 a 16 flores.

During the study of the high montane vegetation of Guatemala (Véliz et al. 2004) and the study of conifers in Guatemala (Véliz et al, 2006), more than 650 vascular plant species were collected, including specimen vouchers made in the Sierra Cuchumatanes. In the Department of Huehuetenango, on Cuilco Mountain, locally known as Peña Blanca, a new species of *Salvia* was discovered and is described below. *Salvia* is the most species-rich genus in the Lamiaceae with over 900 species described (Hedge 1992; Walker & Elisen 2001), and one of its centers of diversity includes the highlands of Guatemala and Mexico, with over 500 species so far described from the New World (Epling 1939; Hedge 1960, 1992; Harley 2004).

Salvia carrilloi Véliz & Quedensley, sp. nov. (**Fig. 1**). TYPE: GUATEMALA. HUEHUETENANGO. Municipio de la Libertad: sierra Cuchumatanes Peña Blanca, cloud forest, 3059 m, N15°30'29.5" W91°54'58.3", 3 Dec 2008, *M.E. Véliz 20540 with L.E. Velásquez M. &R. Véliz* (HOLOTYPE: BIGU; ISOTYPES: AGUAT, CAS, F, MEXU, NY, TEX).

Salviae tortuosae Kunth affinis sed differt calycibus bicoloribus, corollis tubis albis 20–23 mm longis ac lobis magenteis, labio supero 12–16 mm longo infero luteo 9–11 mm longo trilobato.

Herbs to 0.4–1.2 m tall, erect. **Stems** 3–4 mm wide, square, sulcate, green to purple, villous. **Leaves** opposite; petioles 1.5–9 cm long, villous; blades 3–8 cm wide, 5–11 cm long, ovate to deltoid; margins coarsely serrate, bases subcordate to rounded; apices acute to acuminate; adaxial surface sparsely strigose, bullate; abaxial surface glabrous with glandular punctate dots; veins villous. **Inflorescences** 15–21 cm long, lax, 9–16 flowered verticillasters. **Verticillasters** separated 11–22 mm, forming interrupted racemes; subtended by deciduous bracts, lanceolate, tri-nerved, apices acuminate, ca. 3 mm wide, 10–11 mm long. **Calyces** glandular-hispidulous with glandular punctate dots, lobe apices acuminate to cuspidate; upper lobe green, 3–veined, 9–10 mm long; lower lobe pale yellow, bilobed, 12–14 mm long. **Corollas** hispidulous; tube white, 20–23 mm long, upper lobe magenta, hispidulous, 12–16 mm long; lower lobe magenta, glabrous, 9–11 mm long, trilobed. **Stamens** 2, included, attached near base of corolla throat; filament 8–9 mm long; staminal papillae yellow, 3 mm long, attached on corolla throat and perpendicular to filament. **Style** exerted, pilose, ca. 36 mm long, bifurcate, upper branch 1/3 as long as lower branch. **Nutlets** 2 mm long, 1.2 mm wide, light brown, glabrous.

Etymology.—The specific epithet honors José Ernesto Carrillo (1925–1997), Guatemalan botanist and member of the Facultad de Agronomía of the Universidad de San Carlos de Guatemala, mentor and dear friend of the first author.

Distribution and habitat.—Salvia carrilloi is known only from the type locality, Peña Blanca, between 3000 and 3200 m in cloud forest habitat (Fig. 2). Peña Blanca is located in the Sierra Chuchumatanes that extends from west to east in the northwestern part of Guatemala in the Departments of Huehuetenango and Quiché. Woody species of the mentioned cloud forest include *Abies guatemalensis, Acaena elongata, Ceanothus*

Fig. 1. *Salvia carrilloi*. A. Leaves. B. Inflorescence. C. Flower, side view. D. Peña Blanca (Photos by *M. Véliz*).

FIG. 2. Known distribution of *Salvai carrilloi* in Guatemala. Peña Blanca is located in the Sierra Chuchumatanes in the Department of Huehuetenango, Guatemala, near the Mexican border.

azureus, *Chiranthodendron pentadactylon*,*Clethra pachecoana*, *Hedyosmum mexicanum*, *Ocotea salvinii*, and *Oreopanax echinops*. Common herbs are represented by *Alchemilla guatemalensis*, *Halenia decumbens*, *Potentilla heterosepala*, *Roldana acutangula*, *R. heterogama*, *Salvia cinnabarina*, *S. excelsa*, and *S. gracilis*. The geological substrate in the area is characterized by limestones of the Cretaceous and Quaternary calcareous material (IGN 1970). The soil is clay and mosses are abundant.

Phenology.—In flower from November to January.

Salvia carrilloi morphologically resembles *S. tortuosa*, but *S. carrilloi* is a smaller herb and has an erect growth habit, the leaves are smaller, the lower lobe of the calyx is pale yellow, the corolla tube is white and the upper and lower corollas lobes are magenta. With regard to its distribution, *Salvia carrilloi* and *S. tortuosa* are considerably disjunct, with the latter distributed in Colombia and Ecuador. *Salvia tortuosa* has not yet been reported from Central America. Morphology suggests that *Salvia carrilloi* must be classified in the section *Tubiflorae* Benth., of the subgenus *Calosphace* (Benth.) Benth. According to Standley and Williams (1973), 45 species of *Salvia* are found in Guatemala, and 312 species are located in adjacent Mexico (Ramamoorthy & Elliot 1993).

Additional specimens examined. **GUATEMALA. Huehuetenango. Municipio de la Libertad:** Peña Blanca, slopes of the sierra Cuchumatanes, cloud forest, 3193 m, N15°30'21" W91°54'56", 14 Dec 2000, *M. Véliz 10854* with *N. Gallardo and M. Vásquez* (BIGU); Peña

Blanca, slopes of the sierra Cuchumatanes, cloud forest, 2783 m, N15°30'57" W91°54'47.9", 3 Dec 2008, *M. Véliz 20536* (AGUAT, BIGU); Peña Blanca, slopes of the sierra Cuchumatanes, cloud forest, 2979 m, N15°30'33.0" W91°54'56.6", 3 Dec 2008, *M. Véliz 20537* (BIGU, MEXU); Peña Blanca, slopes of the sierra Cuchumatanes, cloud forest, 3016 m, N15°30'32.4" W91°54'58.7", 3 Dec 2008, *M. Véliz 20539* (AGUAT, BIGU, MEXU); Peña Blanca, slopes of the sierra Cuchumatanes, cloud forest, 3037 m, N15°30'28.2" W91°54'38.3", 3 Dec 2008, *M. Véliz 20542* (BIGU, MEXU); Peña Blanca, slopes of the sierra Cuchumatanes, cloud forest, 3025 m, N15°30'29.1" W91°54'38.1", 3 Dec 2008, *M. Véliz 20543* (BIGU, USCG).

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SYNOPSIS OF *MATELEA* S.L. (APOCYNACEAE: ASCLEPIADOIDEAE) IN TRINIDAD, TOBAGO, AND THE ABC ISLANDS

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ABSTRACT

The objective of this work is to provide a synopsis of the species of *Matelea* s.l. (Apocynaceae: Asclepiadoideae) from Trinidad, Tobago, and the ABC Islands (Aruba, Bonaire, and Curaçao) to facilitate their recognition and conservation. Six species are recognized from the area. Three of these reach their northernmost limit on the eastern side of the Caribbean in Trinidad and the ABC islands (*M. reflexa*, *M. rubra*, *M. squiresii*). Two species reach the Lesser Antilles (*M. denticulata*, *M. hirsuta*). One is broadly distributed to the Greater Antilles on the east and to Panama on the west (*M. maritima*).

RESUMEN

El objetivo de este trabajo es aportar una sinopsis de las especies de *Matelea* s.l. (Apocynaceae: Asclepiadoideae) de Trinidad, Tobago, y las Islas ABC (Aruba, Bonaire, y Curaçao) para facilitar su reconocimiento y conservacion. Se reconocen seis especies en el área. Tres de ellas alcanzan su límite norte en el lado este del Caribe en Trinidad y las islas ABC (*M. reflexa*, *M. rubra*, *M. squiresii*). Dos especies alcanzan las Antillas Menores (*M. denticulata*, *M. hirsuta*). Una esta ampliamente distribuida hasta las Antillas Mayores en la costa este y hasta Panamá en el oeste (*M. maritima*).

About fifty species of subtribe Gonolobinae (Apocynaceae: Asclepiadoideae) occur on the islands comprised by the Greater and Lesser Antilles, the Bahamas, Trinidad and Tobago, and Aruba and the Netherland Antilles. Evidence from the chloroplast (Rapini et al. 2003; Liede-Schumann et al. 2005; Rapini et al. 2006; Krings et al. 2008) and nuclear genomes (Krings et al. 2008) supports the monophyly of the subtribe. However, pending resolution of phylogenetic relationships, *Matelea* Aubl. continues to serve as a catch-all for any species not immediately referable to *Fischeria* DC. or *Gonolobus* Michx. (see Krings et al. 2008). The synorganization of androecium and gynoecium appears to have facilitated such a myriad of gynostegial structural variation in this group that it is at times very difficult to discern relationships, much less morphological synapomorphies, in the absence of a resolved phylogeny. Understandably, Woodson's (1941) mass synonymization was born of his frustration with the large variation in corona morphology exhibited by the group. *Matelea* now comprises 230–300 species, of which about half have been described since Woodson (1941), and sixty-six percent of these described in the past three decades. Krings (in press) provided a synopsis of *Matelea* s.l. in the West Indies, including a key to the genera of Gonolobinae in the area. However, Trinidad, Tobago, and the ABC Islands (Aruba, Bonaire, and Curaçao) were excluded from that treatment due their South American affinity. The objective of this work is to provide a synopsis of the species of *Matelea* s.l. from this area to facilitate their recognition and conservation.

RESULTS

Six species of *Matelea* s.l. are recognized from Trinidad, Tobago, and the ABC islands. Of these six, the following three reach their northernmost limit—at least on the eastern and southern side of the Caribbean—in Trinidad or the ABC islands: *M. reflexa* (Hemsl.) Morillo, *M. rubra* (H. Karst.) Spellman & Morillo, and *M. squiresii* (Rusby) Morillo. On the western side of the Caribbean, *M. reflexa* is known from as far north as Nicaragua (although it has apparently not been seen there in the past 150 years sec. Stevens 2001). *Matelea rubra* and *M. squiresii* are northern South American taxa and do not reach Mesoamerica (Krings & Saville 2007; Morillo 2007; Stevens 2009). Of the remaining three species, two reach as far north as the southern

Lesser Antilles (Krings, in press): *M. denticulata* (Vahl) Fontella & E.A. Schwarz (to Grenada) and *M. hirsuta* (Vahl) Woodson (to St. Vincent). Both *M. denticulata* and *M. hirsuta* are also known from Mesoamerica, as far north as Honduras and Nicaragua, respectively (Stevens 2001, 2009). The remaining species, *M. maritima* (Jacq.) Woodson, occurs throughout the West Indies, including the Greater Antilles, and reaches Panama in Mesoamerica (Krings & Saville 2007; Stevens 2009).

Keys and descriptions of the species are provided below. Corona morphological terminology follows Liede and Kunze (1993) and Kunze (1995), although it is recognized that additional work may be needed to clarify issues of family-wide homology (see Endress and Bruyns 2000; Livshultz 2003). Shorthand abbreviations for corona morphology following Liede and Kunze (1993) and Kunze (1995) are as follows: Ca = annular corona of corolline derivation (faucal annulus); Cd = dorsal anther appendage; Ci = interstaminal corona; C(is) = fused interstaminal and staminal corona; Cs = staminal corona.

Species are arranged alphabetically. Herbarium abbreviations follow Index Herbariorum (Holmgren & Holmgren 1998–present). Book abbreviations follow TL-2 (Stafleu & Cowan 1976–1988) and journal abbreviations B-P-H (Lawrence et al. 1968) and B-P-H/S (Bridson & Smith 1991). Author abbreviations follow Brummitt and Powell (1992).

TAXONOMIC TREATMENT

KEY TO THE SPECIES OF *MATELEA* S.L. IN TRINIDAD, TOBAGO, AND THE ABC ISLANDS

1. Corolla urceolate; inflorescence umbelliform ____ **M. hirsuta**
1. Corolla subcampanulate at base; inflorescence racemiform.
  2. Bases of leaf blades rounded or cuneate.
    3. Stems hirsute, pubescence ubiquitous, trichomes yellow-golden, eglandular trichomes antrorse or spreading, the largest ≥ 1.4 mm long, glandular capitate trichomes absent; corolla lobes 4.0–9.2 mm long, gynostegial corona fused into an obcylindric tube (C(is)) obscuring most of the gynostegium except the style head, tube ≥ 1.4 mm tall ____ **M. reflexa**
    3. Stems short-pubescent, pubescence in two lines, trichomes white, eglandular trichomes retrorse, to 0.3 mm long, glandular capitate trichomes spreading, to 0.08 mm long; corolla lobes 2–3.4 mm long, gynostegial corona not fused into a tube around the gynostegium ____ **M. squiresii**
  2. Bases of essentially all leaf blades deeply cordate.
    4. Gynostegial corona pubescent; terminal style-head appendage 0.9–1.6 mm tall, apically capitate ____ **M. maritima**
    4. Gynostegial corona glabrous; terminal style-head appendage absent or reduced to ca. 0.1 mm.
      5. Faucal annulus (corolline corona or Ca) reduced to a distinctly raised protuberance opposite each corolla lobe sinus, short-hispid; gynostegial corona not fused into a tube (C(is)) surrounding the gynostegium, Cs lobes not free; follicle winged, not tuberculate ____ **M. denticulata** s.l.
      5. Faucal annulus absent; gynostegial corona basally fused into a tube surrounding the gynostegium, Cs lobes apically free; follicle tuberculate, not winged ____ **M. rubra**

1. Matelea denticulata (Vahl) Fontella & E.A. Schwarz, Bol. Mus. Bot. Munic. 46:4. 1981. (**Fig. 1A**). *Cynanchum denticulatum* Vahl, Eclog. Amer. 2:23. 1798. TYPE: GUIANA [SURINAM]: *von Rohr120* (HOLOTYPE: C [IDC microfiche photo: Vahl herbarium nr. 17: III, 1!]).

Cynanchum viridiflorum G. Mey., Prim. Fl. Esseq. 141. 1818, nom illegit., non Sims, 1817. *Matelea viridiflora* (G. Mey.) Woodson, Ann. Missouri Bot. Gard. 28:325. 1941. TYPE: GUYANA: *Rodschied 154* (HOLOTYPE: GOET!)

Gonolobus grenadensis Schltr. in Urb., Symb. Antill. 7(3):339. 1912. TYPE: GRENADA: St. Mark Parish, Wooded hillsides near Victoria, elev. 100–300 ft, 24 Nov 1957, *Proctor 17225* (NEOTYPE, designated by Krings 2008: IJ!).

Slender, woody vine. Stems pubescent, pubescence ubiquitous or in two lines, eglandular trichomes retrorse-appressed, glandular capitate trichomes spreading. Leaf blades ovate to elliptic, 5.0–10.0 × 1.6–6.9 cm, adaxial surface glabrous, midvein glabrous or sparsely puberulent basally, eglandular trichomes antrorse, glandular capitate trichomes spreading or absent, abaxial surface glabrous, midvein glabrous or very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, apex acute to acuminate, base cordate, margins entire, colleters 2–5, lanceoloid; petioles 1.7–4.8 cm long, sparsely to moderately pubescent, pubescence more or less restricted to adaxial groove, eglandular trichomes antrorse, glandular capitate trichomes spreading. Inflorescence racemiform, peduncles 2.6–7.7 mm long, sparsely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandular capitate trichomes spreading or absent; pedicels 14.0–20.0 mm long,

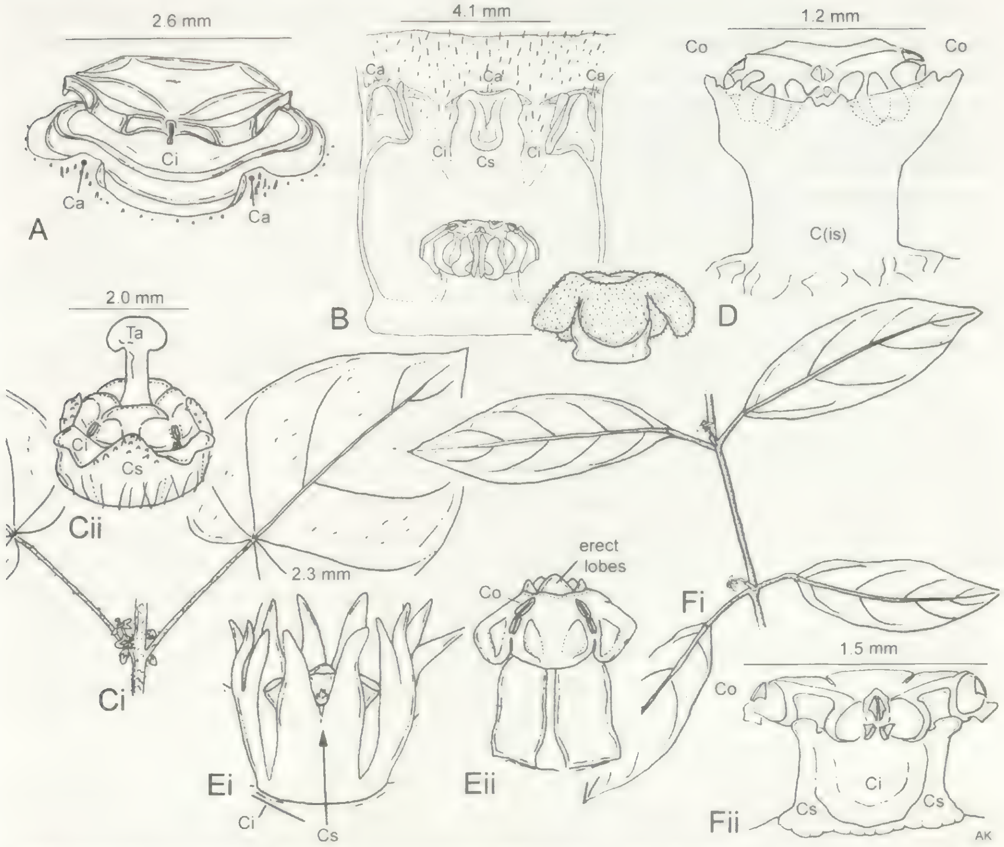

Fig. 1. *Matelea* s.l. in Trinidad, Tobago, and the ABC islands. **A,** *M. denticulata* (gynostegium based on *Dodson & Dodson 15450*, NY). **B,** *M. hirsuta* (corolla and gynostegium based on *Smith & Smith 1862*, NY). **C,** *M. maritima*: i, habit (based on *Ekman H5104*, S); ii, gynostegium (based on *Proctor 41760*, IJ). **D,** *M. reflexa* (gynostegium based on *Clark & Troya 561*, US). **E,** *M. rubra* (based on *Howard 20294*, A, NY): i, gynostegial corona; ii, style-head and subtending stipe. **F,** *M. squiresii* (based on *Fendler 621*, E): i, habit; ii, gynostegium. Ca = annular corona of coralline derivation (faucal annulus); Ci = interstaminal corona; C(is) = fused interstaminal and staminal corona; Co = corpusculum; Cs = staminal corona; Ta = terminal appendage of style-head.

sparsely to moderately pubescent, pubescence ubiquitous or in two lines, eglandular trichomes antrorse, glandular capitate trichomes spreading. Calyx lobes lanceolate, 6.2–7.0 × 1.6–2.3 mm, adaxial surface glabrous, abaxial surface glabrous, apices obtuse to acute, margins entire, colleters 1 per sinus, lanceoloid. Corolla green (fide collectoris), reticulate, subcampanulate at base, tube 0.8–1.0 × 0.8–1.0 mm, lobes imbricate in bud, broadly ovate, 13.0–16.0 × 8.5–9.6 mm, not ocellate, adaxial surface pubescent basally and along right margin, eglandular trichomes spreading, glandular capitate trichomes absent, abaxial surface glabrous, apex obtuse, margins entire. Faucal annulus (corolline corona or Ca) a distinctly raised protuberance opposite each corolla lobe sinus, short-hispid. Gynostegial corona of fused staminal (Cs) and interstaminal parts (Ci), Cs an inverse patelliform depression, not ligulate, Ci an inverse patelliform depression, not ligulate. Style-head 2.5–2.7 mm diam, stipe 0.2–0.5 mm tall, terminal style-head appendage absent. Pollinaria: corpusculum ca. 0.2 mm long, caudicles present, pollinia broadly ovate, 0.6–0.7 × 0.3–0.4 mm. Follicles not seen from the treated area (continental collections exhibit follicles ovoid-fusiform, 8.0–12.0 × 2.7–3.9 cm, glabrous, bases asymmetric, longitudinal wings 5). Seeds not seen from the treated area (continental collections exhibit seeds obovate, 4.8–7.0 × 2.4–3.2 mm, both surfaces reticulate-verrucose, distal margin dentate).

Habitat and Distribution.—Distributed broadly from Central to South America, including Trinidad and Tobago, as well as to the Lesser Antilles (Grenada). Known in the treated area only from roadsides, seasonal forests, and banana fields at low elevations.

Phenology.—Collected in flower in February, March, August, September, November, and December.

Additional specimens examined: **GRENADA. St. George Parish:** Richmond Hill, Aug 1908 (fl), *Bey s.n.* (A). **St. Mark Parish:** wooded hillside near Victoria, 100–300 ft, [31–91 m], 24 Nov 1957 (fl), *Proctor 17225* (A, BM). **TOBAGO.** Moriah, roadside, 27 Feb 1981 (fl), *Adams & Baksh 270* (TRIN); Flagstaff Hill, 13 Jul 1954 (fl), *Baker s.n.* (TRIN [digital image]); Mora Valley, near Rio Claro, low alt., 1 Dec 1957 (fl), *Simmonds s.n.* (TRIN); Little Tobago (Bird of Paradise Island), Ingraham's Walk, 125 m, 15 Aug 1979 (fl), *Webster 24192* (TRIN). **TRINIDAD.** Laventille, 2 Dec 1890 (fl), *Alexander s.n.* (TRIN [digital image]; conf. R.E. Woodson, Jr.); Chatham Beach, 9 Sep 1940 (fl), *Cheesman s.n.* (TRIN [digital image]); Western Rd, near St. Peter's Bay, 17 Mar 1938 (fl), *Cheesman 113* (TRIN [digital image]; conf. R.E. Woodson, Jr.); Diego Martin, River Estate, 16 Sep 1947 (fl), *Dale s.n.* (TRIN [digital image]).

2. Matelea hirsuta (Vahl) Woodson in E.E. Cheesman, Fl. Trinidad 2:170. 1947. (**Fig. 1B**). *Cynanchum hirsutum* Vahl, Eclog. Amer. 2:24. 1798. *Macroscepis hirsuta* (Vahl) Schltr. in Urb., Symb. Antill. 1:265. 1899. Type: TRINIDAD: *von Rohr 92* (holotype: C [IDC microfiche photo: Vahl herbarium nr. 17: III, 3!; isotype: BM!).

Woody vine. Stems pubescent, pubescence ubiquitous, eglandular trichomes spreading, glandular capitate trichomes absent. Leaf blades elliptic or obovate, 7.3–10.5 × 4.8–6.1 cm, adaxial surface moderately to densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, midvein densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, abaxial surface moderately to densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, midvein densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apex abruptly acuminate, base cordate, margins entire, colleters 2–5, lanceoloid; petioles 11.0–23.0 mm long, pubescent, pubescence ubiquitous, eglandular trichomes retrorse-spreading, glandular capitate trichomes absent. Inflorescence umbelliform, peduncles to 10.5 mm long, pubescent, pubescence ubiquitous, eglandular trichomes spreading, glandular capitate trichomes absent; pedicels 1.3–4.2 mm long, pubescent, pubescence ubiquitous, eglandular trichomes spreading or antrorse, glandular capitate trichomes spreading. Calyx lobes ovate 9.0–11.5 × 5.8–6.0 mm, adaxial surface glabrous, abaxial surface densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apices acute, margins entire, colleters 1 per sinus, lanceoloid. Corolla brownish, evidently reticulate or not, urceolate, tube 9.0–10.5 × 7.0–9.0 mm, lobes imbricate in bud, ovate to suborbicular, 4.9–9.7 × 6.1–8.1 mm, not ocellate, adaxial surface moderately to densely pubescent, eglandular trichomes spreading, glandular capitate trichomes absent, abaxial surface moderately to densely pubescent, apex obtuse or rounded, margins entire. Faucal annulus (corolline corona or Ca) present, short hispid. Gynostegial corona of well-developed staminal (Cs) segments, glabrous, adnate to the corolla tube ca. 1.8–2.0 mm above the style-head, ligulate, interstaminal corona (Ci) not well developed, not ligulate. Style-head ca. 3.9–4.1 mm diam, stipe 1.0–1.2 mm tall, terminal style-head appendage absent. Pollinaria: corpuscula ca. 0.4 mm long, caudicles present, pollinia ovate, ca. 0.95 mm × 0.54 mm. Follicles not seen from the treated area (sec. Stevens 2001: follicles asymetrically fusiform, 9–12.5 × 3–4.5 cm, densely pubescent, trichomes glandular, longitudinal wings 5). Seeds not seen from the treated area (sec. Stevens 2001: seeds obovate, 6.5–8.3 × 4.5–5.7 mm, surfaces reticulate-verrucose, distal margin irregularly dentate).

Habitat and Distribution.—Sensu Stevens (2001), this species is broadly distributed from Mesoamerica to South America (including Trinidad) and the Lesser Antilles (St. Vincent).

Phenology.—Collected in flower in March. Collected in fruit in November.

Additional specimens examined: **St. Vincent:** Mar 1890 (fl), *Smith & Smith 1862* (NY). **Trinidad:** Southern Watershed Reserve, Siparia, 8 Sep 1940 (st), *Cheesman & Baker s.n.* (TRIN [digital image]; conf. R.E. Woodson, Jr.); Erin Savanna, 30 Nov 1980 (fr), *Boos & Baksh 67* (TRIN [digital image]); Irois, s.d. (fr), *Broadway 8523* (TRIN [digital image]; conf. R.E. Woodson, Jr.); Quinam Rd, Southern Range, 25 Jun 1929 (st), *Williams s.n.* (TRIN [digital image]; conf. R.E. Woodson, Jr.).

3. Matelea maritima (Jacq.) Woodson, Ann. Missouri Bot. Gard. 28:222. 1941. (**Fig. 1C**). *Asclepias maritima* Jacq., Enum. Syst. Pl. 17. 1760. *Gonolobus maritimus* (Jacq.) R. Br., Mem. Wern. Nat. Hist. Soc. 1:24. 1810. *Ibatia maritima* (Jacq.) Decne. in de Candolle, Prodr. 8:599. 1844. *Lachnostoma maritimum* (Jacq.) G. Nicholson, Ill. Dict. Gard. 2:226. 1884. Type: Herbar. Du Jacquin. 2 Insulae Caribaea. *De Ponthieu* (neotype: BM!, lectotype designated by Krings & Saville 2007 corrected here to neotype).

Gonolobus floccosus Bertol., Opusc. Sci. 4:225. 1823. TYPE: GUADELOUPE: *Anonymous s.n.* (HOLOTYPE: BOLO!).

Ibatia muricata Griseb., Fl. Brit. W.I. 421. 1862. TYPE: ANTIGUA: Cedar Hall, 1849, *Wullschlägel* (LECTOTYPE, designated by Krings & Saville 2007: M!).

Slender, woody vine. Stems pubescent, pubescence ubiquitous or in two lines, eglandular trichomes retrorse, glandular capitate trichomes spreading. Leaf blades ovate to oblong-ovate or orbicular, 1.2–10.5 × 0.7–9.8 cm, adaxial surface lightly pubescent, eglandular trichomes antrorse-spreading, glandular capitate trichomes spreading, midvein pubescence denser than that of the surface, eglandular trichomes antrorse, glandular capitate trichomes spreading, abaxial surface tomentose, eglandular trichomes antrorse, glandular capitate trichomes spreading, midvein densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, apex acute to acuminate, base cordate, margins entire, colleters 3–6, lanceoloid; petioles 8.1–72.3 mm long, pubescence ubiquitous, eglandular antrorse, glandular capitate trichomes spreading. Inflorescence racemiform, peduncles ca. 1.12–1.9 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandular capitate trichomes spreading; pedicels 0.6–4.1 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandular capitate trichomes spreading. Calyx lobes oblong-ovate to oblong ca. (1.1–)2.1–4.9 × 0.8–1.9 mm, adaxial surface glabrous, abaxial surface pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, apices acute, margins entire, colleters 1(–2) per sinus, lanceoloid. Corolla green to yellowish-green (rarely reddish-green) (fide colectoris), not reticulate, subcampanulate at base, tube ca. 0.6–1 × 1.4–1.8 mm, lobes imbricate in bud, lance-oblong 1.6–4.5 × 1.4–3.6 mm, not ocellate, adaxial surface densely pubescent, eglandular trichomes antrorse, gradually reduced in length from corolla lobe base to apex, glandular capitate trichomes absent, abaxial surface densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes very sparse, spreading if present, apex obtuse or acute, margins entire. Faucal annulus (corolline corona or Ca) absent. Gynostegial corona of fused staminal (Cs) and interstaminal (Ci) parts, tube ca. 0.7–0.8 mm tall, papillate-pubescent, Cs apex a triangular lobe, papillate-pubescent up to and including the apex, Ci apically bi- or tri-lobed, lateral margins dissected completely from the Ci apex to the apex of the C(is) tube, medial Ci lobe (if tri-lobed) smaller than the two lateral Ci lobes or of equal dimensions, papillate-pubescent up to, but not including the apex, Ci ligulate basally within, two ridges emanating from the ligule evident to about half way up the C(is) tube. Style-head ca. 1.9–2.2 mm diam, stipe 0.6–0.7 mm tall, terminal style-head appendage 0.9–1.6 mm tall, capitate, not distinctly bi-lobed. Pollinaria: corpuscula ca. 0.2 mm long, caudicles present, pollinia ovate, oblong, or rhombic, ca. 0.6–0.7 mm × 0.28–0.31 mm. Follicles dark green (fide colectoris), narrowly ovoid, 4.1–9.1 × 1.3–5.2 cm, surfaces lanate, eglandular trichomes spreading, glandular capitate trichomes apparently absent, tuberculate, each tubercle ca. 2.8–5.6 mm long, apex broadly capitate or irregularly swollen, ca. 0.7–2.9 mm diam. Seeds obovate, plano-convex, 3.6–6.0 × 1.6–3.4 mm, both surfaces tuberculate, distal margin dentate.

Habitat and distribution.—*Matelea maritima* is known from dry, scrubby coastal thickets from throughout the Greater and Lesser Antilles to northern South America and Panama (Krings & Saville 2007; Stevens 2009).

Phenology.—In its range, *M. maritima* has been collected in flower and fruit year round. In Trinidad, it has been collected in flower in June and from nearby Patos Island in fruit in March (*Britton et al. 529*, GH).

Additional specimens examined: **Trinidad:** roadside, 9 Jun 1929 (fl), *Broadway 7220* (G, K, MO, S, US, Z); field, near landing, 26 Jun 1932 (fl), *Broadway 7220* (A, S). See Krings and Saville (2007) for an extensive list of additional specimens.

4. **Matelea reflexa** (Hemsl.) Morillo, Ernstia 24:39. 1984. (**Fig. 1D**). *Gonolobus reflexus* Hemsl., Biol. Cent.-Amer., Bot. 2(11): 333. 1882. TYPE: NICARAGUA: Chontales, 1867–1868 (fl), *Tate 241 (410)* (HOLOTYPE: K, n.v.; ISOTYPE: BM [digital image!]).

Fimbristemma brasiliense Schltr., Notizbl. Königl. Bot. Gart. Berlin 6(55):178. 1914. *Matelea brasiliensis* (Schltr.) Spellman, Phytologia 25:438. 1973. TYPE: BRAZIL: Seringal S. Francisco, Alto Rio Acre, Jun 1911 (fl), *Ule 9529* (HOLOTYPE: B, n.v.; ISOTYPE: L [digital image!]).

Slender, woody vine. Stems coarsely pubescent, pubescence ubiquitous, eglandular trichomes antrorse or sometimes spreading, glandular capitate trichomes absent. Leaf blades elliptic, ovate, or oblong, 4.5–8.0 × 1.6–5.8 cm, adaxial surface moderately to densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, midvein densely pubescent, eglandular trichomes antrorse, glandular capitate tri-

chomes absent, abaxial surface moderately to densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, midvein densely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apex obtuse, base rounded, truncate, or subcordate, margins entire, apiculum absent, colleters 2–4, lanceoloid; petioles 5.7–22.3 mm long, pubescence ubiquitous, eglandular trichomes antrorse or spreading, glandular capitate trichomes absent. Inflorescence racemiform, peduncles to 5.0 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandular capitate trichomes absent; pedicels 7.5–11.0 mm long, moderately to densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandular capitate trichomes antrorse or spreading, about as long as the eglandular trichomes. Calyx lobes oblong, lanceolate, or elliptic, 1.3–2.0 × 0.6–0.8 mm, adaxial surface glabrous, abaxial surface coarsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apices obtuse, margins entire, colleters 0–1 per sinus, lanceoloid. Corolla yellow to white-cream (fide collectoris), subcampanulate at base, tube 0.7–0.1.5 × 1.3–1.8 mm, lobes imbricate in bud, ovate or deltate, 4.0–6.2 × 1.7–2.2 mm [considerably lower than Stevens range!], not ocellate, adaxial surface minutely pubescent, eglandular trichomes spreading, glandular capitate trichomes absent, abaxial surface coarsely pubescent, eglandular trichomes mostely spreading, some antrorse, glandular capitate trichomes spreading, about as long as the eglandular trichomes, apex obtuse or rounded, margins entire. Faucal annulus (corolline corona or Ca) absent. Gynostegial corona of fused staminal (Cs) and interstaminal (Ci) parts forming an obcylindric tube with five pockets defined by vertical Cs walls attaching tube to gynostegium, C(is) glabrous on both sides, Cs an elevated ridge, ca. 1.2 mm tall at junction with gynostegium and 1.4 mm tall at its free apex, not ligulate, Ci apex free, base attached to gynostegium, ligulate. Style-head ca. 1.1–1.6 mm diam, stipe 1.2–1.4 mm tall, terminal style-head appendage absent. Pollinaria: corpuscula ca. 0.25 mm long, caudicles present, pollinia narrowly ovoid, ca. 0.5 mm × 0.2 mm. Follicles unknown. Seeds unknown.

Distribution and habitat.—This species is distributed from Nicaragua to Brazil and Peru. It occurs from terra firma to submontane and cloud forests, from 50–1200 m elev.

Phenology.—Collected in flower in January (Trinidad) and December.

Additional specimens examined: **BRAZIL:** between Maloca and Rio Cauaburi, in forest on terra firma, 50–100 m elev., 31 Dec 1965 (fl), *Silva & Brazão 60785* (VEN). **PANAMÁ. Panamá:** between Cerro Jefe and Encida, 2100–2700 ft elev. [640–823 m], 17 Jan 1968 (fl), *Dwyer 8218* (VEN). **TRINIDAD:** Arima-Blanchisseuse Rd., 11th mile, 2000 ft elev. [610 m], roadside, 20 Jan 1952 (fl), *Baker s.n.* (TRIN [digital image]; conf. Sandwith). **VENEZUELA. Sucre:** Cagigal, Peninsula de Paria, trail from El Paujil to summit of the mountain, S-facing slopes, trail leading to El Brasil, beginning of cloud forest, 10°38–39'N, 62°43'W, 700–750 m elev., 20 Feb 1980 (fl), *Steyermark, Liesner, and Carreño Espinosa 121426* (VEN).

Notes.—At a glance, the flowers of *M. reflexa* appear similar to those of members of the *Fimbristemma* Turcz. group of *Gonolobus* because of the conspicuous tube surrounding the gynostegium. However, the tube in *M. reflexa* appears to be gynostegial, not coralline, in origin. It is attached directed to the gynostegial stipe via five Cs rays and completely glabrous. Members of the *Fimbristemma* group in contrast exhibit a gynostegium surrounded by two tubes: the innermost is gynostegial in origin and completely glabrous, whereas the outermost is coralline in origin (thus a modification of the Ca) and typically pubescent, at least along the rim.

5. Matelea rubra (H. Karst.) Spellman & Morillo, Phytologia 34:152. 1976. (**Fig. 1E**). *Omphalophthalma rubra* H. Karst., Fl. Columb. 2:119–120, t. 163. 1866. *Matelea rubra* (H. Karst.) Aa & Stoffers, Proc. Kon. Ned. Akad. Wetensch., C 84(3):300. 1981, nom. illeg. TYPE: COLOMBIA. MAGDALENA: Santa Marta, *Karsten s.n.* (HOLOTYPE: LE, Sennikov, pers. comm., n.v.).

Slender, woody vine. Latex white. Stems pubescent, pubescence ubiquitious or in two lines, eglandular trichomes retrorse, glandular capitate trichomes spreading. Leaf blades ovate to oblong-ovate, 2.1–8 × 1.2–7.3 cm, adaxial surface pubescent, eglandular trichomes generally antrorse, glandular capitate trichomes spreading, midvein more densely pubescent than leaf surface, eglandular trichomes antrorse, glandular capitate trichomes spreading, abaxial surface densely pubescent, eglandular trichomes antrorse, midvein less densely pubescent than surface, eglandular trichomes mostly antrorse or spreading, sometimes retrorse, glandular capitate trichomes spreading, apex acuminate or acute, base cordate, margins entire, colleters 2–5, lanceoloid; petioles 9.9–58.1 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse, glandu-

lar capitate trichomes spreading. Inflorescence racemiform, peduncles 1.5–3.1 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse-spreading, glandular capitate trichomes absent; pedicels 1.0–4.7 mm long, densely pubescent, pubescence ubiquitous, eglandular trichomes antrorse-spreading, glandular capitate trichomes absent or spreading. Calyx lobes oblong-ovate, ca. 2.6–4.1 × 1.0–1.5 mm, adaxial surface glabrous, abaxial surface sparsely but coarsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apex acute, margins entire, colleters 1 per sinus, lanceoloid. Corolla maroon, green with brown stripes, greenish-yellow or white (fide collectoris), subcampanulate at base, tube ca. 0.6–1.7 × 0.6–0.7 mm, lobes imbricate in bud, ovate-lanceolate, 5.5–6.5 × 1.7–2.3 mm, adaxial surface glabrous with sparse pubescence at apex, eglandular trichomes spreading, glandular capitate trichomes absent, abaxial surface glabrate or very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apex obtuse, margins entire. Faucal annulus (Ca) absent. Gynostegial corona of fused staminal (Cs) and interstaminal parts (Ci), tube ca. 1.3–2.4 mm tall, Cs apex a shallow, rounded lobe, ca. 0.2 mm tall, glabrous or papillate-pubescent near the apex, a single ridge leading from the base of the stipe to the base of the Cs within, Ci bi-lobed, lobes extending 2–3.8 mm beyond their medial sinus, glabrous, Ci not ligulate within. Style-head ca. 2.0–2.6 mm diam, stipe 1.28–1.35 mm long, not toothed, terminal style-head appendage absent or reduced to ca. 0.1 mm tall, central rim of style-head exhibiting five erect lobes, each ca. 0.24–0.26 mm tall. Pollinaria: corpuscula ca. 0.3 mm long, caudicles present, pollinia broadly ovate, ca. 0.66 × 0.46 mm. Follicles green and brown (fide collectoris), ovate, 6.3–6.9 × 1.9–3.9 cm, minutely pubescent, tuberculate, tubercles 4.9–8.9 mm long, broadly capitate, apical swelling white, irregular, 2.0–6.6 mm diam., color and pubescence as that of follicle surface. Seeds pyriform, plano-convex (or at least appearing so due to incurved margins), 4.1–4.3 × 2.1–2.5 mm, curved surface with a raised median ridge, both surfaces tuberculate, distal margin dentate.

Distribution and habitat.—*Matelea rubra* is known from subxerophytic associations over limestone from each of the ABC islands, as well as Colombia and Venezuela.

Phenology.—Collected in flower from September through February. Collected in fruit in March and November.

Additional specimens examined: **ARUBA:** Savoneta, Oct 1969 (fl), *Arnoldo-Broeders 3816* (A); sewage treatment plant area, 17–21 Jan 1986 (fl & fr), *Howard 20294* (A, NY); Hooiberg, N-hill, Scree hill, 16 Feb 1999 (fl), *van Proosdij et al. 667* (A, NY). **BONAIRE:** NW of Goto Meer, 6 Nov 1952 (fl), *Stoffers 579* (A). **CURAÇAO:** Christoffelberg, 26 Dec 1952 (fl), *Stoffers 1190* (A); Sint Joris, "Marie Pompoen," 9 Mar 1917 (fr), *Curran & Haman* 238 (GH); Hato plain, second limestone plateau near Hato-airport, 9 Feb 1999 (fl), *van Proosdij et al.* 597 (A). **VENEZUELA. Falcón:** Cardón, 2 km SE de Punto Fijo, 20 m elev., 27 Nov 1978 (fl & fr), *Flora Falcón (HW, RW, TR) 37* (VEN). Zulia: Bolívar, carretera Maracaibo–Carora, entre km 5–7 al SE de Sabana de la Plata (km 42), 27 Oct 1977 (fl), *Bunting 5770* (VEN); Bolívar, Parque Yaguasa, entre la carretera intercomunal y el Lago de Maracaibo, 0–25 m elev., 24 Sep 1979 (fl), *Bunting & Galué 7930* (VEN).

6. Matelea squiresii (Rusby) Morillo, Ernstia 24:39. 1984. (**Fig. 1F**). *Gonolobus squiresii* Rusby, Descr. S. Amer. Pl. 101. 1920. Type: VENEZUELA: Lower Orinoco, 1896 (fl), *Rusby & Squires 294* (HOLOTYPE: NY!)

Matelea mediocris Woodson, Fieldiana, Bot. 28(3):510-511. 1953. Type: VENEZUELA: Bolívar, vicinity of Tumeremo, between S of town and airport, 305 m elev., 18 Dec 1944 (fl). *Steyermark 60690* (HOLOTYPE: MO [digital image!]; ISOTYPE: F [digital image!], VEN!)

Slender, woody vine. Stems pubescent to glabrescent, pubescence in two lines, eglandular trichomes retrorse, glandular capitate trichomes spreading. Leaf blades elliptic, slightly oblanceolate, or oblong, 3.5–5.8 × 1.1–2.1 cm, adaxial surface glabrous to very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, midvein glabrous to very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, abaxial surface glabrous to very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, midvein glabrous to very sparsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, apex obtuse, to abruptly short acuminate, base rounded, margins entire, apiculum pubescent on both sides, colleters 2–4, lanceoloid; petioles 5.8–11.7 mm long, pubescence more or less restricted to adaxial ridge, eglandular trichomes antrorse or spreading, glandular capitate trichomes spreading. Inflorescence racemiform, peduncles to 1.8 mm long, glabrous; pedicels 1.9–2.9 mm long, glabrous or sparsely pubescent, pubescence ubiquitous, eglandular trichomes absent, glandular capitate trichomes spreading. Calyx lobes oblong, lanceolate, or elliptic, 1.0–2.0 × 0.6–0.8 mm, adaxial

surface glabrous, abaxial surface coarsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes spreading, apices obtuse, margins entire, colleters 1 per sinus, lanceoloid. Corolla yellow green with green lines (fide collectoris), subcampanulate at base, tube 0.5–0.7 × 0.9–1.2 mm, lobes imbricate in bud, ovate or deltate, 2.0–3.4 × 1.5–2.3 mm, not ocellate, adaxial surface glabrous or pubescent, eglandular trichomes spreading, glandular capitate trichomes absent, abaxial surface coarsely pubescent, eglandular trichomes antrorse, glandular capitate trichomes absent, apex obtuse or rounded, margins entire. Faucal annulus (corolline corona or Ca) absent. Gynostegial corona of fused staminal (Cs) and interstaminal (Ci) parts, Cs an elevated ridge, ca. 0.5 mm tall, ligulate, ligule ca. 0.1 × 0.2 mm, apex truncate, Ci appearing as a sinus between the Cs, not ligulate. Style-head ca. 1.5–1.8 mm diam, stipe 0.5–0.6 mm tall, terminal style-head appendage absent. Pollinaria: corpuscula ca. 0.1 mm long, caudicles present, pollinia narrowly ovoid, ca. 0.3 mm × 0.2 mm. Follicles not seen. Seeds not seen.

Distribution and habitat.—*Matelea squiresii* is known from northern South America (Suriname to Venezuela) to Trinidad. It occurs in a variety of habitats from savannas to mountain forests.

Phenology.—Collected in flower in May, June, and December.

Additional specimens examined: **TRINIDAD:** Maracas-Tucuche, El Tucuche, 16 Jun 1975 (fl), *Raynal s.n.* (TRIN [digital image]; Mt. Tucuche, summit, 5 Jun 1947 (fl), *Baker s.n.* (TRIN [digital image]; conf. R.E. Woodson, Jr.); Tucuche, near summit, 12 May 1949 (fl), *Baker s.n.* (TRIN [digital image]; conf. R.E. Woodson, Jr.). Piarco-Arima, Mausica savannah, 4 Dec 1947 (fl), *Baker s.n.* (TRIN [digital image]; dupl. conf. W.D. Stevens).

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BOOK REVIEW

RICHARD CONDIT, ROLANDO PÉREZ, AND NEFERTARIS DAGUERRE. 2011. **Trees of Panama and Costa Rica.** (ISBN-13: 978-0-691-14707-9, hbk.; 978-0-691-14710-9, pbk.). Princeton University Press, 41 William Street, Princeton, New Jersey 08540, U.S.A. (**Orders:** press.princeton.edu/titles/9289.html). $85.00 (hbk.), $45.00 (pbk.), 552 pp., 438 color figures, 5 line illustrations, 482 maps, 6" × 9".

This book is a comprehensive and authoritative field guide to the trees of Panama and Costa Rica. It is offered as a learning tool for budding botanists, ecologists, and nature tourists, yet its clarity and user-friendliness make it accessible to all.

Introductory chapters offer readers an overview of the forests in Panama and Costa Rica highlighting its great species richness. The authors consolidate the forest communities into five major categories—dry, moist, wet, lower montane, and upper montane—and discuss the impact of human development on Central American forests, noting how, but for a few remnant areas, dry tropical forests have been almost entirely wiped out, making way for cities, towns, and pasture. Additionally, the authors provide a basic overview of tree identification before diving into detailed family and species descriptions.

The heart of the field guide examines tree species by family. These pages cover 493 tree species and include 438 color plates and photos detailing leaves, flowers, fruit, bark, and when possible, magnification of such. Clear and concise descriptions are broken down by family and then by genus and species. The authors offer tips to facilitate recognition with color distribution maps, local tree names in Spanish and English, and refer the reader to other similar or related species. The appendices round out the guide offering a tabular summary of leaf traits of known tree families as well as information on families not covered.

The authors spent 15 years compiling lists of Panamanian trees. Costa Rica however, shares 72% of its tree species with Panama, affording the authors the opportunity to develop similar lists for Costa Rica based on occurrence records from the Missouri Botanical Garden, the Global Biodiversity Information Facility, and the New York Botanical Gardens. This guide is truly the product of years of research and hard work by many.

This book fills an important niche among field guides, as few address trees specific to Central America. When they do, they are often described together with trees of the Americas, diluted among discussions of trees from North and South America, or they are thrown in with general nature and rainforest books. While a few gaps remain, this book is the most comprehensive and accessible field guide available for this region.

This is the field guide I wish I'd had as a forester living and working in Costa Rica in the mid-1990s. Its only drawback is its large size. This book would have been a welcome addition to the field guide collection in my backpack.—*Gwen Michele Thomas, Texas Master Naturalist, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

THREE NEW ANDEAN SPECIES OF *AULONEMIA* (POACEAE: BAMBUSOIDEAE: BAMBUSEAE) WITH SHEATH AURICLES

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ABSTRACT

Four described species of the neotropical woody bamboo genus *Aulonemia* Goudot (Poaceae: Bambusoideae: Arthrostylidiinae) have prominent lunate, fimbriate, foliage leaf sheath auricles. We describe here three additional sheath-auriculate species from Andean South America. The new Bolivian species **Aulonemia insignis** has dimorphic culms: One type is vegetative and produces numerous, crowded, broad foliage leaves (with purple margins, unique in the genus), while the other type is fertile and produces only a few, small foliage leaves. Two other new Andean species, **Aulonemia fuentesii** (Bolivia) and **A. madidiensis** (Peru and Bolivia), differ from their sheath-auriculate congeners in their broad foliage leaves (4.7–9.3 cm wide) and awnless spikelets. *Aulonemia fuentesii* has foliage leaf blades 13–18 cm long and 4.7–5.7 cm wide, sheath fimbriae 8–15 mm long, and spikelets 23–40 mm long and 4–5 mm wide with 7–13 puberulent, 7–11-nerved fertile florets, while *A. madidiensis* has foliage leaf blades 22–33 cm long and 6.7–9.3 cm wide, sheath fimbriae 20–25 mm long, and narrower spikelets 1.9–2.5 mm wide with 5–7 glabrous, 5–9-nerved fertile florets. The epidermal foliage leaf blade micromorphology of each new species is characterized using scanning electron microscopy.

RESUMEN

Cuatro especies descritas de *Aulonemia* Goudot (Poaceae: Bambusoideae: Arthrostylidiinae), un género neotropical de bambú leñoso, poseen aurículas prominentes, semilunares y fimbriadas en las vainas de las hojas. Presentamos aqui tres especies nuevas, tambien con vainas auriculadas, encontradas en los Andes de América del Sur. La nueva especie Boliviana **Aulonemia insignis** tiene culmos dimorficos: Un tipo es vegetativo y produce numerosas hojas anchas (con márgenes de color purpura, caracter unico en el género), mientras que el otro tipo es fértil y produce pocas hojas pequeñas. Las otras dos nuevas especies andinas, **Aulonemia fuentesii** (Bolivia) y **A. madidiensis** (Peru y Bolivia), difieren de sus congéneres con auriculas por tener hojas anchas (4.7–9.3 cm de ancho) y espiguillas no aristadas. *Aulonemia fuentesii* tiene vainas foliares con fimbrias 8–15 mm de largo y laminas 13–18 cm de largo y 4.7–5.7 cm de ancho, y espiguillas 20–35 mm de largo y 4–5 mm de ancho, con 7–13 flósculos fértiles puberulentos con 7–11 nervios. *Aulonemia madidiensis* tiene vainas foliares con fimbrias 20–25 mm de largo y láminas 22–33 cm de largo y 6.7–9.3 cm de ancho, y espiguillas 20–35 mm de largo y 1.9–2.5 mm de ancho, con 5–7 flósculos glabros con 5–9-nervios. La epidermis foliar de las laminas de cada nueva especie es descrita con microscopía electrónica de barrido.

KEY WORDS: Poaceae, Bambusoideae, *Aulonemia*, Bolivia, Peru, Parque Nacional Madidi

INTRODUCTION

Aulonemia Goudot (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) is a genus of about 45 named species (McClure 1973; Calderón & Soderstrom 1980; Clayton & Renvoize 1986; Judziewicz et al. 1999, 2000). The genus is characterized by culm nodes lacking promontories, each node with a single dominant branch;

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typically abundant leaf fimbriae; and typically reflexed leaf blades. Recent collections (on loan from MO) from Parque Nacional Madidi on the northern slope of the Andes in western Bolivia (http://www.mobot.org/MOBOT/Research/madidi/) revealed several new species of *Aulonemia*, including three with sheath auricles described herein; one of them also occurs in adjacent Peru. None of these taxa is accounted for in recent treatments of Bolivian and Peruvian grasses, including bamboos (Tovar 1993; Renvoize 1998: 38–41; Judziewicz et al. 2010; Judziewicz & Clark 2011). The following key includes the four previously described species of *Aulonemia* with sheath auricles and the three novelties described in this paper.

1. Spikelets with fertile lemmas awned.
  2. Foliage leaf blades narrowly ovate to ovate, (1.9–)3.5–10 cm wide; Ecuador and Peru ______ **A. longiaristata** L.G. Clark & Londoño
  2. Foliage leaf blades linear-lanceolate, 0.7–1.7 cm wide; Venezuela ______ **A. purpurata** (McClure) McClure
1. Spikelets awnless.
  3. Foliage leaf blades 7–19 × 0.7–3.5 cm.
    4. Fimbriae erect; leaf blades 10–19 × (1.5–)2–4 cm; spikelets 12–30 mm long, the florets ca. 6 mm long; Bolivia ______ **A. boliviana** Renv.
    4. Fimbriae radially spreading; leaf blades 7–14 × 1.3–2.2(–3) cm; spikelets 20–37 mm long, the florets 6.5–8.5 mm long; Peru ______ **A. yanachagensis** Judz. & C.D. Tyrrell
  3. Foliage leaf blades 13–33 × 3.7–10 cm.
    5. Culms dimorphic; vegetative (or late-flowering?) culms with foliage leaf blades 13–17.5 × 4–4.7 cm and with purple margins apically and basally, the flowering culms with distant leaf blades 6–7 × 1–1.8 cm; fertile florets 6–7.3(–9) mm long, deep violet-purple; Bolivia ______ **A. insignis** Judz. & Gibbons
    5. Culms monomorphic, vegetative and flowering culms similar; foliage leaf blades 13–33 × 4.7–9.3 cm, uniformly green and not purple-margined; fertile florets (7–)8–10 mm long, tan to greenish suffused with purple; Bolivia and Peru.
      6. Foliage leaf blades 13–18 × 4.7–5.7 cm; fimbriae 8–15 mm long; spikelets 23–40 × 4–5 mm; fertile florets 7–13, puberulent, 7–11-nerved; Bolivia ______ **A. fuentesii** Judz. & Geisthardt
      6. Foliage leaf blades 22–33 × 6.7–9.3 cm; fimbriae 20–25 mm long; spikelets 20–35 × 1.9–2.5 mm, fertile florets 5–7, glabrous, 5–9-nerved; Bolivia and Peru ______ **A. madidiensis** Judz., D.C. Ziegler, & Zueger

Plants parts were measured using a mm ruler. A Hitachi S3400 scanning electron microscope in variable-pressure mode was used to examine the foliage leaf blade epidermises of all three species. Material was cut from well-developed blades without further drying or coating. For *Aulonemia insignis* and *A. fuentesii* just one leaf was examined from the type collections; for *A. madidiensis*, two collections were examined, one from Peru and one from Bolivia. Sections were cut from the marginal stripe of the blade, and as well as from the "non-striped" center of the blade.

Aulonemia insignis Judz. & Gibbons, sp. nov. (**Figs. 1, 2a, 3, 4a–d**). TYPE: BOLIVIA: DEPT. LA PAZ: PROV.: Bautista Saavedra, Área Natural de Manejo Integrado Apolobamba, sector Tajamarca, más allá de Chaka, por el antiguo camino Laji Sorapata – Apolo, 14°52'12"S, 68°46'28"W, 2906 m, bosque bajo de yungas en ceja de monte inferior pluvial de filos, plantas alcholizadas, tejido en silicagel, bambú cerca a 1.7 m, botones; flores, espiguillas pardas, 12 Apr 2009, A.F. *Fuentes & M. Villalobos 14008* (HOLOTYPE: MO; ISOTYPES: LPB not seen, UWSP).

Culmi usque ad 1.7 m longia, 1–3.5 mm diametro. Culmi dimorphi, solidi. Culmi sterili: Vaginae foliorum auriculatae 2–5 mm, fimbriae 20–35(–40) mm longae; laminae 13–17.5 × 4–4.7 cm. Culmi fertili: Vaginae foliorum auriculatae ca. 1 mm longae, fimbriae 2–3 mm longae; laminae 6–7 × 1.5–1.8 cm. Synflorescentia paniculata 20–25 × 20–25 cm. Spiculae 30–45 × 2–2.5 mm, glabrae, 5–7 flosculos continentes; gluma I 0.3–1.3 mm longa, gluma II 3–4.7 mm longa; lemmata fertilia 6–7.3(–9) mm longae, lanceolatae, acutae, violacea-purpurea.

Bamboo to 1.7 m tall, 1–3.5 mm in diameter, apparently cespitose, apically arching to pendulous. Culms dimorphic, apparently solid; branch one per node. Vegetative (or late flowering) culms with foliage leaves about 9 per complement, the rather crowded sheaths stramineous to more commonly strongly suffused with purple, distally sparingly to abundantly hispid with glassy hairs 3–5 mm long; sheath auricles present, lunate, 2.5–5 mm long, purple, densely beset with fimbriae, these 20–35(–40) mm long, abundant, golden, curling, erect to ascending; external ligule 0.2–0.3 mm long, extending only partially around sheath; inner ligules not evident; pseudopetioles 4–6 mm long, puberulent, purple, strongly reflexed; well-developed blades 13–17.5 cm long, 4–4.7 cm wide, broadly lanceolate, strongly reflexed, glabrous, acute and with narrow (1–2 mm wide) dark purple margins apically occasionally extending to one-half of the blade length, distally cuneate and asymmetrical with dark purple margins (1 mm wide), the central leaf margins green, a lighter marginal strip present abaxially. Flowering culms available not with typical foliage leaf complements; leaves with a distinct girdle ca.

FIG. 1. *Aulonemia insignis* (*Fuentes & Villalobos 14008*, MO, UWSP). **A.** Plant at Bolivian type locality (2906 m), 12 April 2009 (Alfredo Fuentes photograph). **B.** Detail of culm leaf showing hispid sheath, auricles, prominent fimbriae, and reflexed blade (Alfredo Fuentes photograph). **C.** Vegetative leaf complement showing numerous crowded, large leaf blades. **D.** Detail of vegetative leaf complement showing sheath auricles, fimbriae, and purple margins of leaf blade bases.

FIG. 2. A. Bolivian upper montane forest habitat (2906 m) of *Aulonemia insignis*, 12 April 2009 (Alfredo Fuentes photograph). B. Bolivian basimontane forest habitat (1700 m) of *Aulonemia fuentesii*, 29 June 2005 (Alfredo Fuentes photograph).

1 mm thick at the base, those in basal and midculm portions consisting of bladeless sheaths only, these 2.5–3.5 cm long, striate, hispid with glassy hairs 3–5 mm long, the summit truncate to concave, 1–2 mm wide; leaves in upper portions of culm with sheath auricles present, lunate, ca. 1 mm long, purple, with abundant delicate golden-brown marginal fimbriae 2–3 mm long; external ligule 0.2–0.3 mm long, extending only partially around sheath; inner ligules not evident; pseudopetioles 1.5–2 mm long, puberulent, purple, strongly reflexed; blades 2–3, distant, strongly reflexed, 6–7 cm long, 1.5–1.8 cm wide, color and shape similar to those of the vegetative culm; peduncle 7–10 cm long, glabrous. Synflorescence an open orbicular panicle 20–25 cm tall, 20–25 cm wide, the primary branches diverging from the rachis by 30–45°, the spikelet pedicels capillary, glabrous. Spikelets 30–45 mm long, 2–2.5 mm wide, slender, awnless, finely puberulent, 5–7-flowered, the florets loosely overlapping; glumes tan-brown, the lower glume 0.3–1.3 mm long, cufflike to linear and recurved, 1-nerved, the upper glume 3–4.7 mm long, lanceolate-ovate, acute, 5–7-nerved; lowermost sterile floret often present, tan-brown, the lemma 5–6 mm long, the palea as long as or slightly protruding from the lemma; fertile florets deep violet-purple, slightly stipitate, the stipes 0.3–0.5 mm long; lemmas 6–7.3(–9) mm long, narrowly ovate, acute, finely 7–9-nerved; paleas 6–7.5 mm long, often slightly longer than the lemmas, bicarinate. Flowers with lodicules 3, 1.3–1.7 mm long, sometimes protruding from the gaping floret at anthesis, hyaline, rhombic, with a distinct midnerve and 3–4 fine nerves in a fan-shaped arrangement, acute, their apices fringed with 7–10 erect, clear, readily deciduous cilia 2–3.5 mm long; stamens 3, the anthers 2.7–3.5 mm long, purple; pistil with stigmas 2, hispid. Fruit not seen.

Leaf micromorphology (*Fuentes & Villalobos 14008*, UWSP). Terminology follows Ellis (1979).

Adaxial (upper) surface (Fig. 4a):

Costal zones.—Rigid in appearance, corrugated and raised above intercostal zones, spaced 140–200 μm apart.

Papillae.—Common to scattered; globose, appearing warty; generally uniform in size, ca. 4 μm in diameter.

Stomates.—Not present.

Interstomatal cells.—Not present.

Long cells.—70–90 μm long, ca. 5 μm wide; outline markedly sinuous, interlocking, apparently flat; papillae arranged in single rows with 2–5 per row.

Bulliform cells.—One row evident in intercostal zone; elongate (length indeterminate).

Prickles.—None seen.

Short cells.—One seen; cross-shaped; ca. 15 μm long, ca. 12 μm wide; raised.

Microhairs.—Few; 2-celled, appearing equal in length; basal cell deflated, oblong, ca. 28 μm long, 13–16 μm wide; apical cell deflated, ca. 32 μm long.

Macrohairs.—None seen.

Abaxial (lower) surface (Fig. 4b–d):

Costal zones.—Spaced 140–200 μm apart.

Papillae.—Abundant; globose to slightly compound; large, generally uniform in size, ca. 6 μm in diameter.

Stomates.—Common; apparently low dome-shaped; stomates alternating; stomatal rows 3, adjacent to costal zones.

Interstomatal cells.—60–70 μm long, ca. 10 μm wide; outline indeterminate; papillae present, abundant, arrangement variable, apparently 1–2-rowed, 5–8 per row.

Long cells.—Dimensions difficult to discern due to dense papillae, ca. 65 μm long, ca. 20 μm wide; papillae arranged in single rows, 5–10 per row.

Prickles.—Abundant, ca. 5/10,000 μm^2; mostly in intercostal zones, present in costal zones; 65–85 μm long, 20–40 μm wide; base deflated.

Short Cells.—Apparently rectangular in shape; dimensions difficult to discern due to dense papillae, ca. 16 μm long, ca. 7 μm wide; apparently depressed into the costal zone.

Microhairs.—Few; bicellular; basal cell deflated, ca. 38 μm long, ca. 13 μm wide; apical cell deflated, 18–28 μm long.

Macrohairs.—None seen.

FIG. 3. *Aulonemia insignis* (*Fuentes & Villalobos 14008*, MO, UWSP). **A.** Flowering culm showing few, small foliage leaf blades. **B.** Spikelet. **C.** Lower glume. **D.** Upper glume. **E.** Lowest sterile lemma. **F.** Fertile lemma. **G.** Fertile palea. **H.** Lodicule. **I.** Stamen. **J.** Pistil. Illustration by Eva C. Hathaway.

Aulonemia insignis is distinctive in its bi-colored foliage leaves with both the base and apex of the blade having a distinctive wine-purple marginal stripe (Fig. 1c-d), hence the specific epithet "insignis," alluding to its resemblance to a military insignia.

Dimorphic culms, otherwise rarely developed in *Aulonemia*, are present in *A. insignis*. "Type 1" (Fig. 3) culms are elongate, arching, pendulous, and exhibit numerous bladeless sheaths on the middle and lower internodes, and a few distant leaves with small blades on the upper internodes. "Type 2" (Fig. 1c) culms are relatively short but have numerous large, crowded leaf blades. Based on the single collection and a careful examination of Fig. 1a, it appears that "Type 1" may represent an early-flowering culm, while "Type 2" may be just coming into flower. The Brazilian species *Aulonemia aristulata* (Döll) McClure sometimes produces extremely dimorphic culms, with tiny (a few cm tall) reduced leafless flowering culms produced from the base of "normal" leafy, flowering culms (Tarciso Filgueiras & Pedro Viana, pers. comm.).

Aulonemia boliviana Renv. may be closely related to *A. insignis*. The former species differs in its monomorphic culms, narrower leaf blades (1.5–)2–4 cm wide that lack marginal purple stripes, and shorter spikelets only 12–30 mm long. *Aulonemia viscosa* (Hitchc.) McClure from Costa Rica (Pohl 1980; Pohl & Davidse 1994) has distinctly purple-suffused blade bases, but is otherwise quite different morphologically from *A. insignis*.

Alfredo Fuentes (pers. comm.) notes the habitat of the new species as "open areas of a very wet upper montane forest (or upper montane cloud forest) in [areas] frequently exposed to winds and clouds" (Fig. 2a). He notes associates as *Weinmannia microphylla* Kunth (Cunoniaceae), *Bomarea cornuta* Herb. (Alstroemeriaceae), *Ternstroemia* sp. (Pentaphyllacaceae), *Clusia* sp. (Clusiaceae) and *Miconia* sp. (Melastomataceae). A species of the bamboo genus *Chusquea* Kunth is also visible in the background of one of his photos of *Aulonemia insignis* (Fig. 1a).

Aulonemia fuentesii Judz. & Geisthardt, sp. nov. (**Figs. 2b, 4e–f, 5**). Type: BOLIVIA. La Paz: Franz Tamayo, Parque Nacional Madidi, entre Carjata y Río Yana Lomas, 14°34'12"S, 68°54'00"W, 1700 m, bosque con *Juglans boliviana*, sabanas y matorrales subandino superior estacionales, pasto macollero colonial hasta 2.5 m, frutos maduros y viejos, abundante en chaparrales quemados, 29 Jun 2005, *A. Fuentes, E. Cuevas & R. Cuevas 9112* (holotype: MO; isotypes: LPB not seen, UWSP).

Culmi usque ad 2.5 m longia, 0.7 cm diametro. Vaginae foliorum auriculatae, fimbriae 8–15 mm longae; laminae foliorum 13–18 cm longae, 4.7–5.7 cm late. Synflorescentia paniculata 45 cm longae, 30 cm latae. Spiculae 23–40 mm longae, 4–5 mm latae, puberulentes, 7–13 flosculos continents; gluma I 2–3.5 mm longa, glume II 3.5–5 mm longa; lemmata fertilia 8–10 mm longa, lanceolatae, acutae.

Cespitose colonial bamboo; culms up to 2.5 m tall, at least 0.7 cm in diameter in available material, the culms weak and hollow. Internodes striate, stramineous, obscurely green-maculate, glabrous or with a few appressed 1 mm long cilia below. Leaves with sheaths striate, stramineous, obscurely green-maculate, glabrous or with a few appressed 1 mm long cilia below, the margins efimbriate, the apex with a prominent lunate purple brown 4–8 mm long fimbriate auricle on one side, the fimbriae 8–15 mm long, delicate, curling, golden-brown, more-or-less radiate, the outer ligule 1 mm long, on the side opposite the auricle prolonged into an ovate, loosely confluent group of fimbriae ca. 5 mm long; inner ligule not evident; pseudopetiole 2–3 mm long; blades 13–18 cm long, 4.7–5.7 cm wide, ovate, somewhat reflexed, obtuse to nearly truncate at the slightly asymmetrical base, acuminate at the apex, glabrous, the margins cartilaginous, antrorsely scabrous. Peduncle ca. 20 cm long, stout, glabrous, striate, and shining. Synflorescence an ovoid panicle up to at least 45 cm tall and 30 cm wide, the primary branches whorled and ascending at about a 45° angle, the secondary and tertiary branches lax, the spikelet pedicels up to 4 cm long, smooth and capillary. Spikelets 23–40 mm long, 4–5 mm wide, stramineous, the bracts acute and awnless; glumes glabrous, the lower glume 2–3.5 mm long, lanceolate, 1–3-nerved; upper glume 3.5–5 mm long, narrowly lanceolate, 3–5-nerved; lowermost floret sterile, lacking a palea, the lemma 6–7 mm long, 5–9-nerved; fertile florets 7–13, the lemmas 8–9 mm long, broadly lanceolate, acute, glabrous in the upper half, finely appressed-puberulent in the lower half, finely 7–11-nerved, the midnerve and main lateral nerves sometimes slightly excurrent as submucros, the lemma thus appearing tridentate; paleas 8–9.5 mm long, usually slightly protruding from the lemmas, bicarinate, the keels ciliolate. Flowers with lodicules 3, 1.3–1.5 mm long, rhomboid, acute, 2-nerved, transparent, fringed with erect, clear, readily deciduous cilia

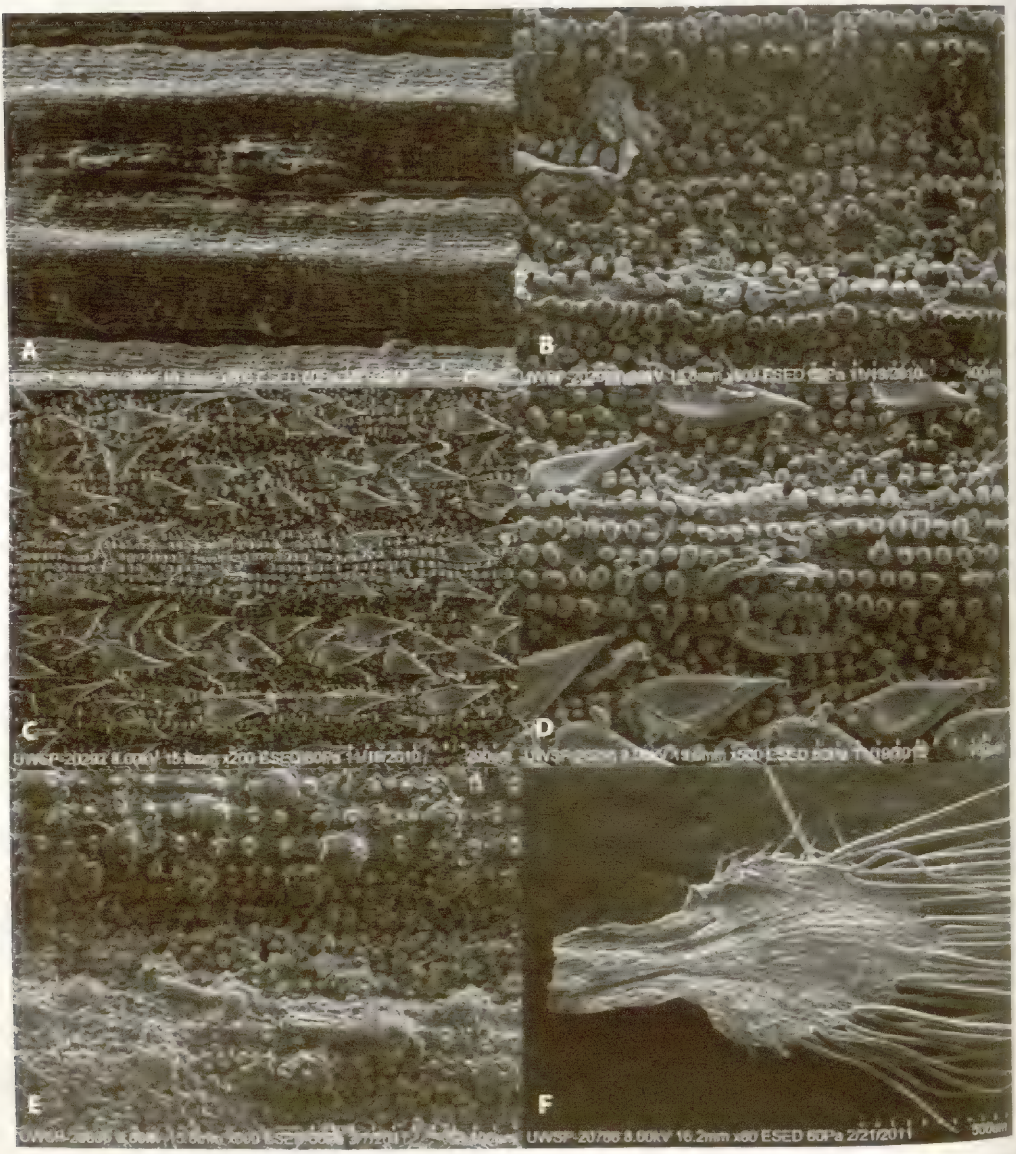

FIG. 4. Scanning electron micrographs (SEMs). **A.** Adaxial (upper) leaf blade epidermis of *Aulonemia insignis* (*Fuentes & Villalobos 14008*, UWSP). **B–D.** Abaxial (lower) leaf blade epidermis of *Aulonemia insignis* (*Fuentes & Villalobos 14008*, UWSP); B from central part of blade, showing absence of prickles. C-D from marginal stripe, showing abundant deflated prickles. **E.** Abaxial (lower) leaf blade epidermis of *Aulonemia fuentesii* (*Fuentes et al. 9112*, UWSP). **F.** Lodicule of *Aulonemia fuentesii*, showing abundant, elongate, readily deciduous cilia (*Fuentes et al. 9112*, UWSP).

1.5–2.5 mm long (Fig. 4f); stamens not seen; pistil not seen. Fruit immature, a brown linear caryopsis 3–4 mm long with a long linear hilum.

Leaf micromorphology (*Fuentes et al. 9112*, UWSP); the material available was in weathered, overmature condition and many character states were not easily determinable. Terminology follows Ellis (1979).

Adaxial (lower) surface: Surface glabrous, sparsely papillate, with scattered conical prickles 30–38 µm tall.

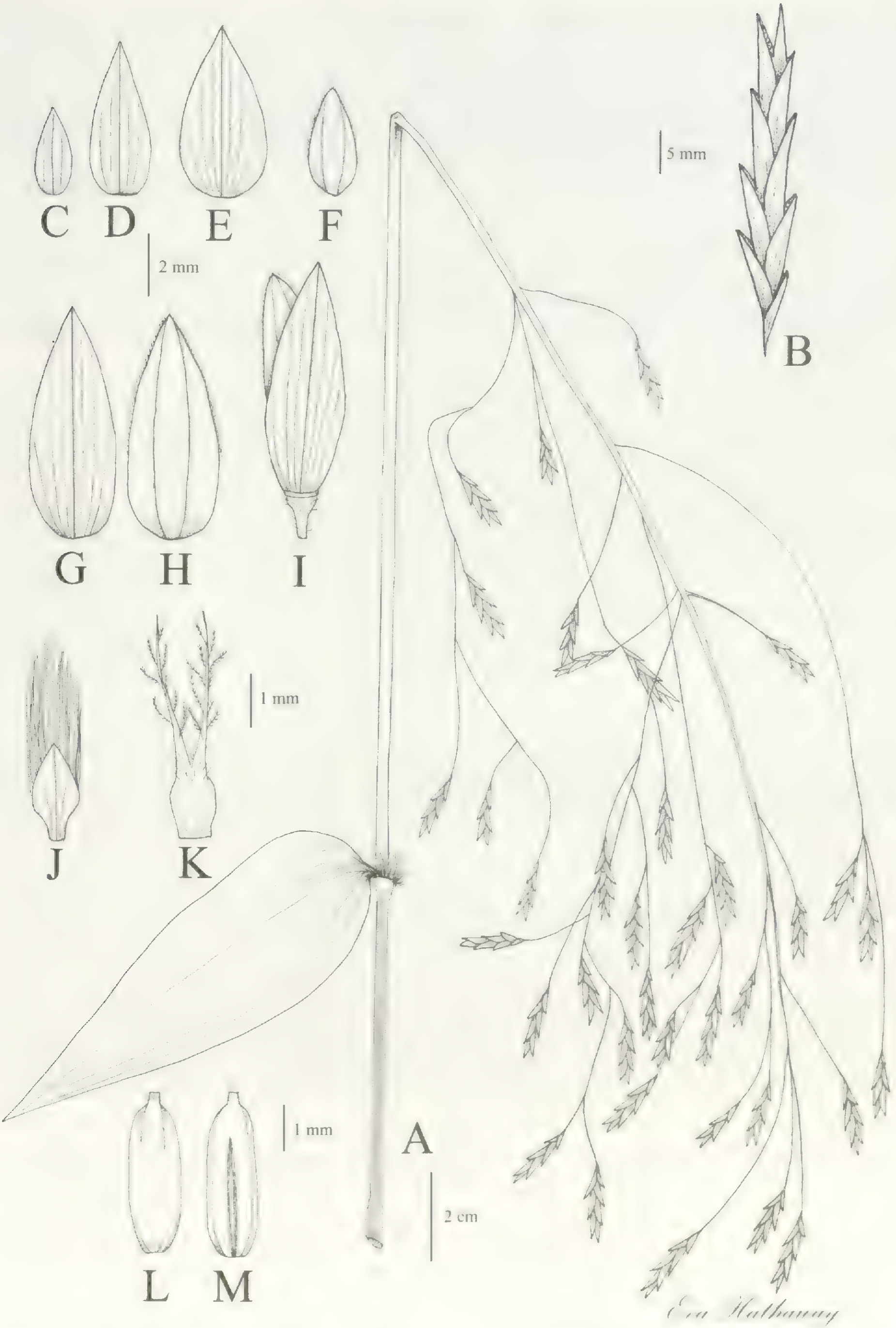

FIG. 5. *Aulonemia fuentesii* (*Fuentes et al. 9112*, UWSP). A. Flowering culm. B. Spikelet. C. Lower glume. D. Upper glume. E. Lowest sterile lemma. F. Lowest sterile palea. G. Fertile lemma. H. Fertile palea. I. Fertile floret. J. Lodicule. K. Pistil. L. Caryopsis, dorsal view. M. Caryopsis, ventral view. Illustration by Eva C. Hathaway and Eric J. Geisthardt.

Abaxial (lower) surface (Fig. 4e):

Costal zones.—Spaced 200–240 μm apart.

Papillae.—In general abundant, globose; simple.

Stomates.—Difficult to discern, apparently throughout intercostal zone; apparently deeply sunken and over-arched by papillae.

Interstomatal cells.—Not readily discernable, obscured by overarching papillae.

Long cells.—Difficult to discern, apparently throughout intercostal zone; apparently deeply sunken and over-arched by papillae.

Prickles.—None seen.

Short cells.—Common, 20–24 μm in diameter, slightly raised, sparse in intercostal zones, 2–3 rows (25–30/mm) in costal zones.

Microhairs.—Occasional, not well-preserved; bicellular; basal cell 30–33 μm long, ca. 7 μm wide, not deflating; apical cell 35–40 μm long, ca. 5 μm wide, deflated.

Macrohairs.—Occasional, 45–55 μm long, slender.

Aulonemia fuentesii is known only from the type specimen, and is named in honor of Alfredo F. Fuentes Claros (b. 1971), Investigador Asociado at the Herbario Nacional de Bolivia, ecologist, bryologist, conservationist, and prolific collector of the flora of Parque Nacional Madidi. The new species differs from *Aulonemia madidiensis* by the characters given in the key above; briefly, it is a vegetatively less robust species with more robust, floriferous spikelets.

Fuentes (pers. comm.) describes the habitat of *Aulonemia fuentesii* as basimontane seasonal forest (Fig. 2b) and savanna, interspersed with anthropogenic, frequently burnt chaparrals in which his eponym is locally dominant. He also noted the following associates at the type locality: *Juglans boliviana* (C. DC.) Dode (Juglandaceae; dominant in primary forests), *Ceroxylon weberbaueri* Burret (Arecaeae), *Barnadesia woodii* D.J.N. Hind (Asteraceae), *Miconia tiliifolia* Naudin (Melastomataceae), *Justicia kuntzei* Lindau (Acanthaceae), *Mucuna rostrata* Benth. (Fabaceae), and *Spirotheca rosea* (Seem.) P.E. Gibbs & W.S. Alverson (Malvaceae).

Aulonemia madidiensis Judz., D.C. Ziegler, & Zueger, sp. nov. (**Figs. 6–7**). TYPE: BOLIVIA. LA PAZ: Franz Tamayo, Parque Nacional Madidi, N de Apolo, bosque andino semideciduo del sector Yarimita, 14°32'48"S, 68°41'37"W, 930–940 m, 2 m, espigas frutales cafes a moradas, 8 Mar 2005, *Araujo-Murakami, Jorgensen & Cuevas 1741* (HOLOTYPE: MO; ISOTYPES: LPB not seen, UWSP).

Culmi usque ad 2 m longa, 0.5–1 cm diametro. Vaginae foliorum auriculatae, fimbriae 20–25 mm longae; laminae foliorum 22–33 cm longae, 6.7–9.3 cm late. Synflorescentia paniculata usque ad 55 cm longae, 40 cm latae. Spiculae (20–)25–35 mm longae, 1.9–2.5 mm latae, glabrae, 5–7 flosculos fertiles continents; gluma I 1–3(–5) mm longa, glume II (2–)3–5(–6) mm longa; lemmata fertilia (7–)8.5–10 mm longa, lanceolatae, acutae.

Habit unknown; culms reportedly 2 m tall, in available material 5–10 mm in diameter, weak, thin-walled, hollow, stramineous and faintly green-maculate, smooth, striate, glabrous, the lumen occupying about 70% of the diameter of the culm; nodes brownish. Culm leaves not seen in available material. Foliage leaves glabrous, the sheaths striate, stramineous, faintly green-maculate, slightly glaucous, lacking marginal fimbriae, with a pair of prominent deciduous purplish-brown lunate auricles (one auricle conspicuously larger than the opposite auricle) 7–12 mm long bearing conspicuous radiate, curling, delicate, golden-brown fimbriae 20–25 mm long; outer ligules ca. 1 mm long, fringed with delicate fimbriae up to 3 mm long; inner ligules not evident; pseudopetioles 3–4 mm long, thickened; blades 22–33 cm long, 6.7–9.3 cm wide, broadly lanceolate, somewhat coriaceous, ascending on available material, obtuse to cuneate at base, acuminate at apex, glabrous, the margins cartilaginous, smooth and somewhat tessellate below and scaberulous above. Peduncle up to at least 15 cm long, stout and glabrous. Synflorescence an ovoid panicle up to at least 55 cm tall and 40 cm wide, the rachis and primary branches angled, glabrous, stramineous with faint green maculations, sparingly glaucous, the primary branches spreading and abundantly rebranched; spikelet pedicels up to 4 cm long, capillary, antrorsely scabrous. Spikelets (20–)25–35 mm long, 1.9–2.5 mm wide, slender, glabrous, the bracts all lanceolate, acute, and awnless, slightly bicolored (stramineous suffused with purplish near their apices); lower glume 1–3(–5)

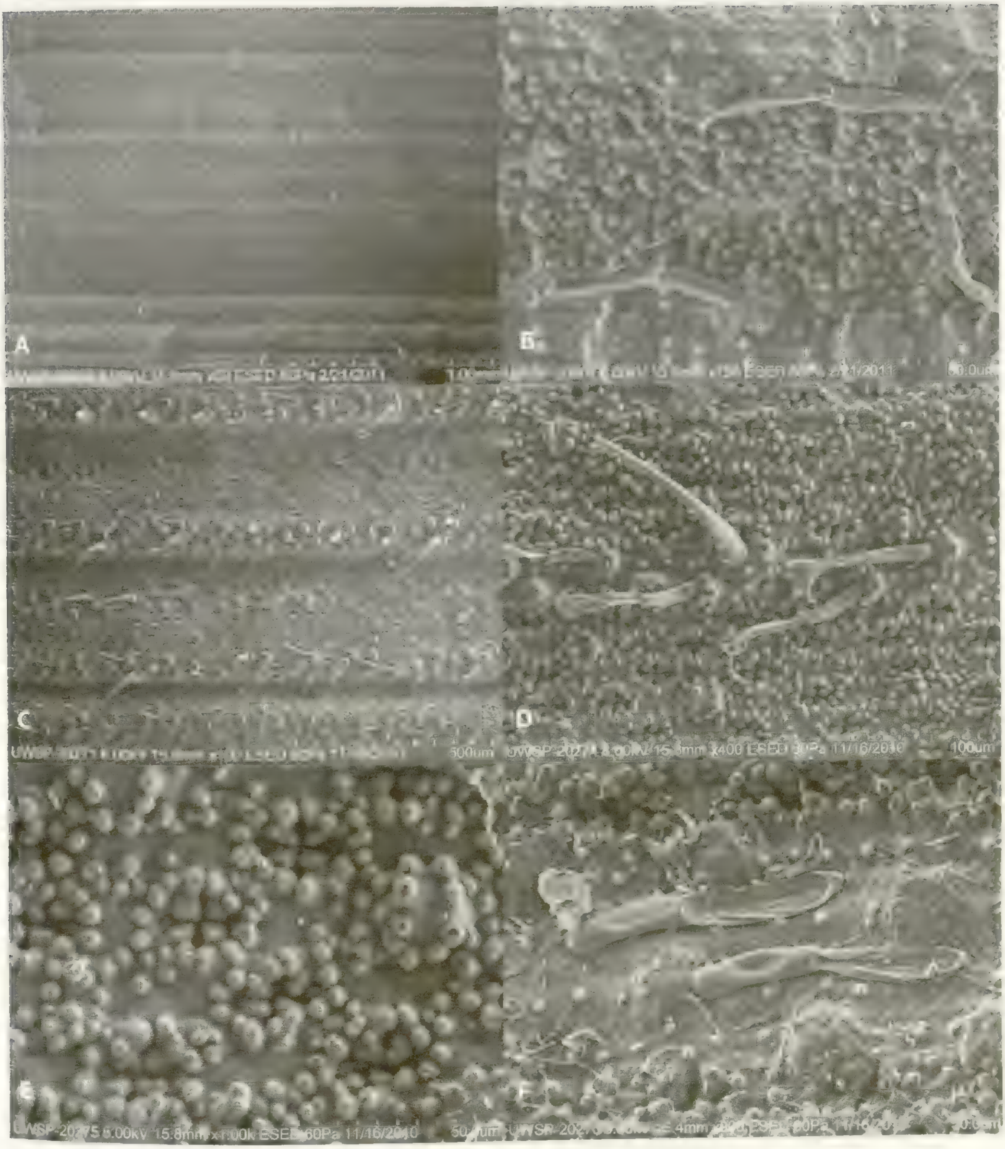

Fig. 6. Scanning electron micrographs (SEMs) of abaxial (lower) leaf blade epidermis of *Aulonemia madidiensis*. A-B based upon *Araujo-Murakami et al. 1741* (UWSP), from Bolivia; C-F based upon *Vargas 17282* (US), from Peru. Aspects highlighted: B and F, bicellular microhairs; D, cilia; E, stomates over-arched on four corners by papillae.

mm long, 1–3(–5)-nerved; upper glume (2–)3–5(–6) mm long, 3–7-nerved; sterile florets 3(4); lowest sterile floret lacking a palea, the lemma 3–8 mm long, 5–7-nerved; fertile florets 5–7, the lemmas (7–)8.5–10 mm long, 5–9-nerved; fertile paleas 2.3–4.5 mm long, bicarinate; uppermost floret reduced and sterile. Flowers with lodicules 3, 0.5–2 mm long, rhombic, 2–3-nerved to the apex, tipped with abundant erect, clear, readily deciduous cilia 1.1–1.9 mm long; stamens 3, the anthers 0.5–2 mm long; pistil with 2 hispid stigmas. Fruit not seen.

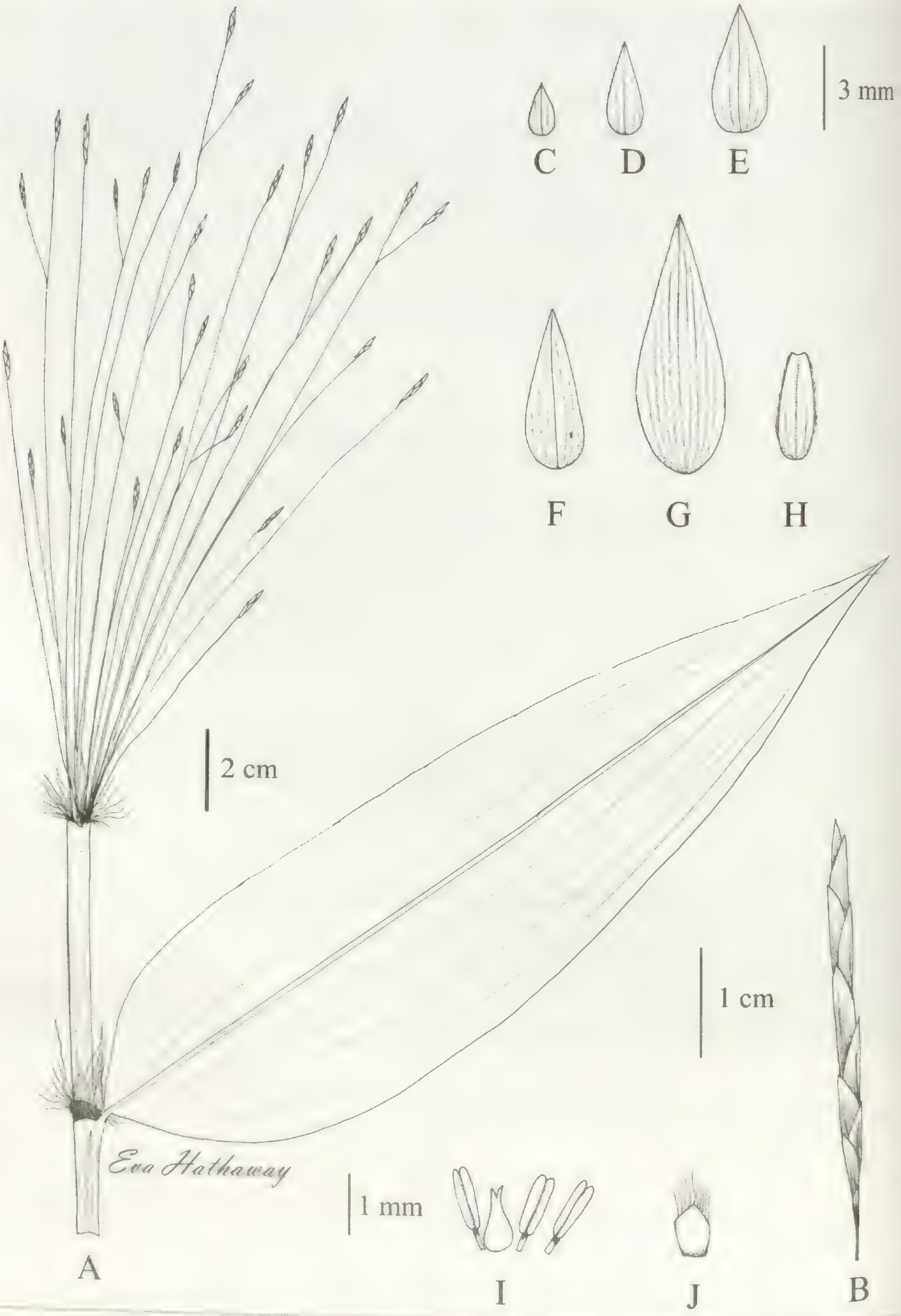

Fig. 7. *Aulonemia madidiensis* (*Paniagua et al. 5895*, Bolivia, UWSP). A. Flowering culm. B. Spikelet. C. Lower glume. D. Upper glume. E. Lowest sterile lemma. F. Second lowest sterile lemma. G. Lowermost fertile lemma. H. Fertile palea. I. Stamens and pistil. H. Lodicule. Illustration by Eva C. Hathaway.

Leaf micromorphology. Terminology follows Ellis (1979).

Abaxial (lower) surface of Bolivian specimen (Fig. 6a–b; *Araujo-Murakami et al. 1741*, UWSP):

Costal zones.—Spaced 140–190 µm apart.

Papillae.—In general very abundant, globose; simple; variable; waxy coat.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; each stomate overarched by 4 irregularly compound papillae, each papillae 4–7 µm long; stomatal rows 4–6, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—33–37 µm long, narrow, width variable; ends indeterminable due to overarching papillae; papillae absent.

Long cells.—Rectangular, 94–110 µm long, 14–21 µm wide, outline of cells sinuous; papillae common, in one or two rows, 5–6 per row/cell, 4–7 µm long, globose.

Prickles.—None seen.

Short cells.—Abundant, 26–28 µm tall, 16–22 µm wide, abundant, slightly raised, in ca. 5 rows (60–70/mm) in intercostal zones, ca. 3 rows (30–45/mm) in costal zones.

Microhairs.—Common; bicellular; basal cell 28–47 µm long, 7–9 µm wide; apical cell ca. 44 µm long.

Macrohairs.—Few; distinctly conical, 118–142 µm long.

Leaf anatomy – abaxial (lower) surface of Peruvian specimen (Fig. 6c–f; *Vargas 17282*, US):

Costal zones.—Spaced ca. 280 µm apart.

Papillae.—Common to abundant, globose to slightly oblique.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; cross-shaped stomates; each stomate overarched by 4 irregularly compound papillae, each papillae 3–6 µm long with 10–13 papillae surrounding each stomate; stomatal rows 4–6, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—19–24 µm long, narrow, width approximately 9 µm; ends indeterminable due to overarching papillae; papillae sparse, 3–5 per cell.

Long cells.—Rectangular, 47–85 µm long, up to ca. 14 µm wide, outline of cells sinuous; papillae sparse, 3–12 per cell, 3–5 µm long, apparently minutely concave at summit.

Prickles.—None seen.

Short cells.—Abundant, 14–24 µm tall, nearly round, in costal zones, not evident in intercostal zone.

Microhairs.—Common; bicellular; basal cell ca. 41 µm long, ca. 9 µm wide; apical cell 53–59 µm long and 6–8 µm wide.

Macrohairs.—Common; 118–142 µm long, 9–14 µm wide.

Additional specimens examined: **BOLIVIA. La Paz:** Franz Tamayo, Parque Nacional Madidi, sobre la senda que va de Virgen del Rosario hacia Mojos, a dos horas bajando por la orilla izquierda del Río Tuichi, 14°34'50"S, 68°41'27"W, 975 m, graminoide de 3 m de alto, inflorescencias nuevas verde parduscas, 7 Nov 2003, *N. Paniagua, L. Cayola, L. Cuevas, C. Cuevas 5895* (MO-2); Franz Tamayo, Senda Virgen de Rosario-Mojos, entre el Arroyo Wichu Wichu y Sumpulo, siguiendo por una senda que se separa de las senda principal, 14°35'24"S, 68°46'03"W, 1280 m; bosque montano semideciduo, de 10 m de alto, en el filo de la loma, sotobosque denso; bambú de 1 m, individuos juveniles, erectos, formando matas compactas; culmo redondo, hueco, liso, verde con manchas moradas mas intensamente en la base de los internudos; hojas del culmo caducas; hoja de las ramas verde claro en el envés, frescas después del corte, *Jimenez 5266* (MO). **PERU. Cusco:** Prov. La Convención, Palma Real, Alto Urubamba, 900–1000 m, borde monte, 16 Apr 1966, *Vargas 17282* (US-2).

Etymology.—Named after Parque Nacional Madidi in Bolivia, this robust species has prominent large, dark, "wrap-around," lunate sheath auricles, large foliage leaf blades, and large, effuse panicles of slender, awnless, somewhat short bi-colored spikelets. *Aulonemia madidiensis* differs from *A. fuentesii* in the characters given in the key, and from the Ecuadorian endemic *A. longiaristata* in its awnless spikelets. It is unusual in the genus for its low elevation range (900–1280 m) and its subandean semi-deciduous forest habitat. Associates noted by the collectors at the type locality included *Acacia loretensis* J.F. Macbr. (Fabaceae), *Adenanthera colubrina* (Vell.) Brenan (Fabaceae), *Casearia gossypiosperma* Briq. (Salicaceae), *Gallesia intregrifolia* (Spreng.) Harms (Phytolaccaceae), and *Phyllostylon rhamnoides* (J. Poiss.) Taub. (Ulmaceae).

Another Peruvian collection from Depto. Cusco could possibly be this species: Urubamba: Dist. Machu Picchu, Pampacahua, bosque humedo, 13°06'S, 72°16'W, 2485 m, hierba 4 m, flores lilas, inflorescencias en panoja, 22 Jan. 2005, *L. Valenzuela, E. Suclli, J. Farfán, V. Chama & N. Anaya 4635* (MO). However, its foliage leaf blades are relatively shorter and more ovate (approximately 23 × 7 cm) than that of the type specimen, its (very immature) spikelets are only 9–12 mm long, and it is found at a much higher elevation (2485 m). A fragmentary, high elevation (3100 m) collection from Depto. Cusco: Prov. La Convención, San Luis, 16 Jan. 1968, bosque húmedo subtropical, 1–2 m tall, flowering, *Chávez Alfaro 38* (US-2), may pertain to this species, but has smaller foliage leaf blades 22 cm long and 4 cm wide, and spikelets only 12–14 mm long. Perhaps the elevation given on the label is in error; it seems unlikely that a humid subtropical forest grows at such a high elevation.

ACKNOWLEDGMENTS

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CREMOSPERMA VERTICILLATUM (GESNERIACEAE), A NEW SPECIES FROM NORTHWESTERN ECUADOR

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ABSTRACT

Recent expeditions to the northwestern slopes of the Ecuadorian Andes and preliminary work on a revision of *Cremosperma* (Gesneriaceae) have resulted in the discovery of a new species. The new species, **Cremosperma verticillatum,** is distinguished from other congeners by the presence of evenly spaced leaves in a whorled arrangement on elongate erect shoots, decumbent stems, and elongate petioles.

RESUMEN

Expediciones recientes a la vertiente noroccidental de los Andes Ecuatorianos, y el trabajo preliminar de revisión del genero *Cremosperma* (Gesneriaceae) han llevado a descubrir una nueva especie: *Cremosperma verticillatum.* La nueva especie se distingue de sus congéneres por hojas en posición verticilada, uniformemente espaciadas a lo largo de ramas erectas, de tallos decumbentes, y de pecíolos elongados.

KEY WORDS: *Cremosperma*, Gesneriaceae, Taxonomy, Flora of Ecuador, Mindo Loma

INTRODUCTION

Cremosperma is a genus of small terrestrial or saxicolous herbs ranging from Costa Rica to Peru. Kvist and Skog (1988) provided a thorough treatment of the *Cremosperma* species known from Ecuador and estimated the genus to comprise 24 species. Two *Cremosperma* species were recently published from Colombia (Fernández-Alonso 2006) and Ecuador (Clark & Skog 2011). The description of *Cremosperma verticillatum* brings the total diversity of the genus to 27 species. The monophyly of *Cremosperma* and its placement in the tribe Beslerieae is strongly supported by molecular data from the nrDNA ITS region (Roalson & Clark 2006); a combined analysis of ITS and cpDNA *trnL-F* (Clark et al. 2010); and cpDNA *ndhF* (Smith 2000). Morphological features that distinguish *Cremosperma* from other genera in the Beslerieae include the presence of terminally clustered flowers on a well-developed peduncle and filaments of the stamens adnate to the corolla tube for half of their length.

TAXONOMIC TREATMENT

Cremosperma verticillatum J.L. Clark & B.R. Keener, sp. nov. (**Fig. 1**). TYPE: ECUADOR. PROVINCIA PICHINCHA: cantón San Miguel de los Bancos, Sendero Cascada, Mindo Loma Cloud Forest Reserve, km 73.5 via Calacali-La Independencia (3 km past the entrance to the village of Mindo), 0°0'44"S, 78°44'29"W, 1800 m, 27 May 2007, *J.L. Clark 9775* (HOLOTYPE: US; ISOTYPES: BRIT, CAS, K, MO, NY, QCNE, SEL, UNA).

A aliis speciebus *Cremospermatis* differt aequaliter dispositis foliis insidentibus elongato erecto cauli, foliis verticillatis et pedicellis elongatis.

Cremosperma pusillum C.V. Morton var. *ecuadorense* C.V. Morton, J. Wash. Acad. Sci. 25:284–291. 1935. TYPE: ECUADOR. Provincia PICHINCHA, Mt. Pichincha, 1800 m, 21 Jan 1856, *W. Jameson* (HOLOTYPE: K; ISOTYPES: E, K-2 sheets, P, W).

Terrestrial herb; stems 20–40 cm tall, decumbent at base, arched and ascending to erect distally, rarely branched, terete to slightly angled, sulcate in distal ½, tomentose with septate trichomes, densely tomentose in distal ⅓, also scurfy with small amber colored protuberances. **Leaves** bullate when fresh, membranaceous when dry, usually with 3 leaves per node, often opposite at proximal first and second node, equal to subequal at each node (rarely unequal); petioles terete, 0.4–5.0 cm long, tomentose; blade elliptic to ovate, 2.5–5.5 × 1.5–3.7 cm, base obtuse and asymmetrical, apex obtuse to rounded, margin crenate to serrate, tomentose,

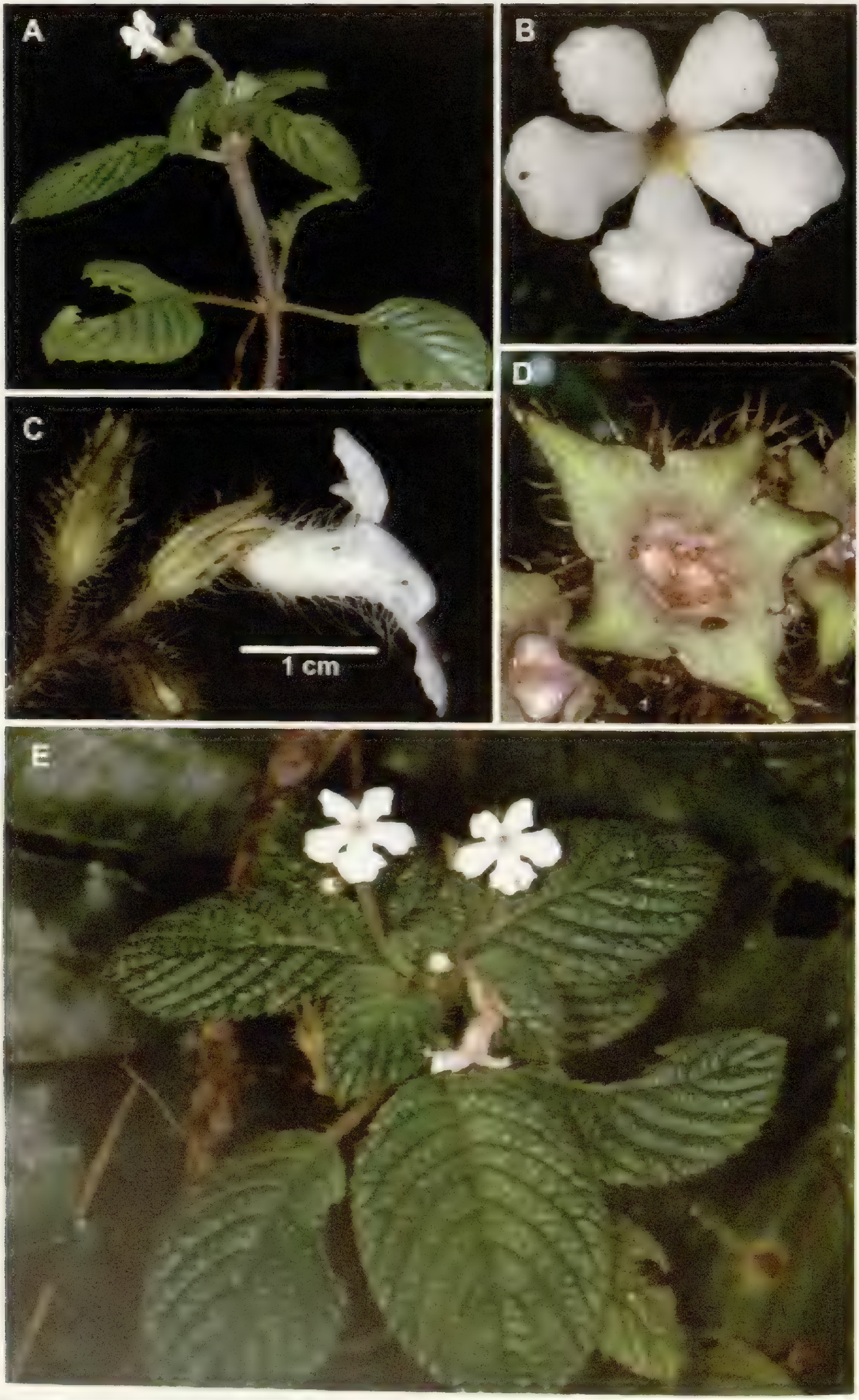

FIG. 1. *Cremosperma verticillatum*. **A.** Elongate shoot showing whorled leaves. **B.** Face view of corolla. **C.** Lateral view of flower. **D.** Splash fruit with 4-valved capsule and persistent calyx lobes. **E.** Habit. (Photos by J.L. Clark; A & D. *J.L. Clark & P. Herrera 10912*; B , C. & E. *J.L. Clark & C. Aulestia 12200*).

abaxially pale green, pilose on veins, adaxially dark green, midvein strigose on proximal ⅓–¾, area between lateral veins glabrous at base then becoming strigose in distal ⅔ with trichomes arranged linearly. **Inflorescence** a reduced pair-flowered cyme, appearing clustered and pseudoumbellate, in upper leaf axils, peduncle 1–4 cm long, (1-) 2–5 mature flowers/inflorescence, often with remnant pedicel scars appearing gland-like; bracts absent. **Flowers** pedicellate, pedicels 1–5 mm long, pilose; calyx 6–7 mm long, lobes 5, fused for ½ of their length, equal, lobes erect during anthesis, persistent and spreading in fruit to form a splash cup to 11 mm wide, apex obtuse, uniformly green, outside pilose, inside glabrous; corolla posture oblique relative to calyx, to 1.5 cm long, tubular, base to mid-region 2 mm in diameter, becoming apically ventricose on lower side to 4 mm wide at apex, white with yellowish upper region of throat, outer surface of tube pilose, throat and corolla lobes abaxially pilose, inner surface of tube glabrous, throat and base of corolla lobes with clustered gland-tipped trichomes, corolla lobes glabrous distally, limb bilaterally symmetrical, lobes reflexed and unequal, lower three lobes oblanceolate, ca. 6 × 2 mm, upper two lobes rotund, 5 × 2 mm, margins entire, slightly undulate; stamens 4, didynamous, included; filaments adnate to base of corolla for 1–2 mm and free for 1.5–2 mm, glabrous; anthers broader than long, ca. 0.4 × 0.9 mm; staminode absent; nectary annular, forming a ring around base of ovary, glabrous; ovary superior, glabrous, ca. 1.7 × 0.6 mm, style and stigma glabrous. **Fruit** a dry 4-valved capsule, globose, ca. 2.5 mm in diameter, calyx lobes persistent and spreading in fruit with potential to act as a splash cup mechanism to spread seeds; seeds numerous, elliptic to ovoid, ca. 0.5 × 0.2 mm, reddish brown, surface alveolate, with ridges of alveoli often forming tubercles.

Cremosperma verticillatum is differentiated from other congeners by elongate erect shoots with leaves that are isophyllous and whorled (Fig. 1A). Most species of *Cremosperma* have opposite leaves that are equal or nearly in size (isophyllous), while other species are strongly anisophyllous (e.g., *Cremosperma anisophyhllum* J.L. Clark & L.E. Skog, *C. reldioides* L.P. Kvist & L.E. Skog, and *C. veraguanum* Wiehler). Upper- and mid-leaves tend to differ in relative petiole length with the latter being longer and the former being shorter. The variable petiole length can be attributed to the maturity of development with the younger leaves having shorter petioles relative to leaf blade and mid- and lower-leaves with longer petioles relative to leaf blade size. The petioles of the mid-leaves of *Cremosperma verticillatum* are relatively elongate (> 5 cm in length) and exceed the length of the leaf blade. Most *Cremosperma* species have petioles that are shorter than the length of the leaf blade. In species that are strongly anisophyllous the petioles are nearly sessile. *Cremosperma verticillatum* is also distinguished from other congners by the presence of gland-like pedicel scars. Other species of *Cremosperma* that have been observed with gland-like pedicel scars are *Cremosperma reldioides* and *C. anisophyllum*. The presence of gland-like pedicel scars may be more common than indicated in the *Cremosperma* treatment by Kvist and Skog (1988).

The presence of whorled leaves was a defining character for *Cremosperma pusillum* C.V. Morton. In addition to the typical variety, Morton (1934) described *C. pusillum* var. *ecuadorense* C.V. Morton. *Cremosperma pusillum* var. *typica* [*pusillum*] was discussed by Morton (1934) as being collected by E.F. André from "Tambo de Savanilla" in Nariño, Colombia in which he wrote, "This agrees in all particulars with the André specimens." André collected in Colombia and Ecuador in 1876 (Smith 1965), but the locality Sabanilla is along the eastern Andean slopes in the southern Ecuadorian province of Zamora-Chinchipe and not in Colombia as indicated by Morton (1934). The Sabanilla Range is located 75 km south of the city of Loja and is currently part of the Tapichalaca Nature Reserve that is managed by Fundación de Conservación Jocotoco. There are at least three other species (*Bomarea longipes* Baker, *Centropogon heteropilis* E. Wimm. and *Centropogon quebradanus* E. Wimm.) collected by André with Sabanilla Range being the type locality. The treatment of *Cremosperma* by Kvist and Skog (1988) repeated Morton's error (1934) by citing the holotype of *Cremosperma pusillum* as being originally collected in Colombia instead of Sabanilla in southern Ecuador. A paper by Fernández-Alonso (2006) documents recent collections of *Cremospserma pusillum* from Colombia (Antioquia and Cauca) that are deposited at COL and JAUM. The authors of this paper did not study the Colombian collections, but images in Fernández-Alonso (2006) of field collections (*J.R.I Wood 5371*) are consistent with material from southern Ecuador.

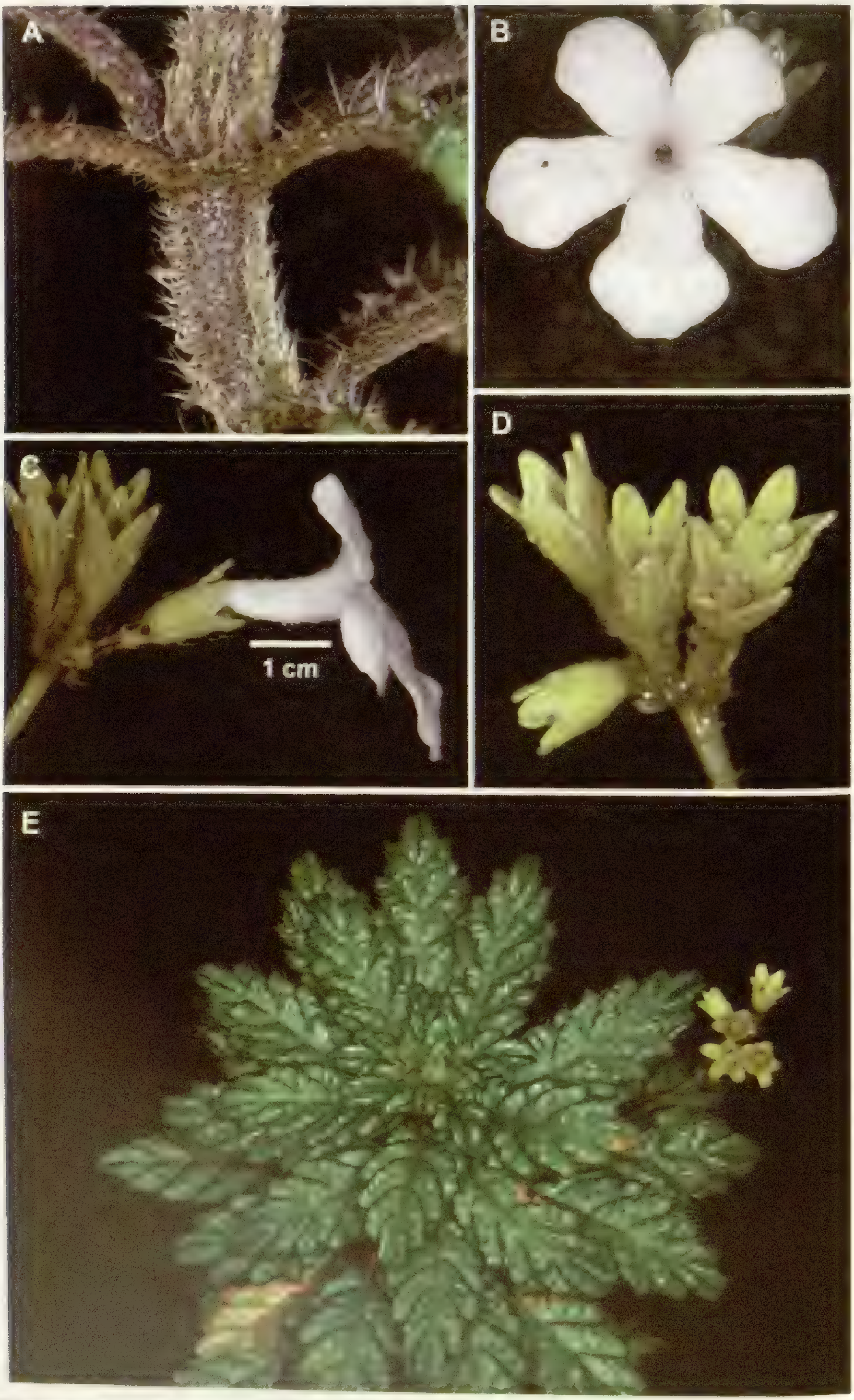

Fig. 2. *Cremosperma pusillum*. **A.** Shoot showing whorled leaves. **B.** Face view of corolla. **C.** Lateral view of flower. **D.** Calyx lobes. **E.** Habit. (Photos by J.L. Clark of *J.L. Clark & Gesneriad Research Expediton Participants 12400*).

Cremosperma pusillum var. *ecuadorense* was described from a single collection by W. Jameson from Mt. Pichincha, Ecuador. Morton was probably inclined to recognize two varieties of one species instead of two separate species because both species have whorled leaves and he was under the impression that the type localities by André and Jameson were from geographically similar areas (e.g., Nariño in southern Colombia and adjacent Mt. Pichincha in northern Ecuador). We now know that the type localities are geographically distinct with Pichincha in northeastern Ecuador and Sabanilla in southeastern Ecuador.

It is not possible to elevate Morton's variety to the rank of species even though *Cremosperma verticillatum* is identifiable with *Cremosperma pusillum* var. *ecuadorense*. There already exists a species with a specific epithet honoring Ecuador (*Cremosperma ecuadoranum* L.P. Kvist & L.E. Skog). It should be noted that Kvist and Skog (1988) treated Morton's variety as a heterotypic synonym of *Cremosperma hirsutissimum* Benth. var. *hirsutissimum*. The other three varieties of *Cremosperma hirsutissimum* have strictly opposite leaves. It is clear based on herbarium work, field observations, and multiple expeditions to both type localities that whorled leaves is a consistent character that differentiates these two species from all other *Cremosperma* species in Ecuador.

Cremosperma pusillum is a small terrestrial herb that rarely reaches 20 cm in height and often appears with leaves in a basal rosette or in apical clusters (Fig. 2E) on short erect shoots that are embedded in moss-covered areas. The leaves of *C. pusillum* are 0.5 to 1.5 cm long and the adaxial surface is dark green and often variegated (Fig. 2). *Cremosperma verticillatum* is 20-40 cm tall and the leaves are longer (2.5–3.7 cm). In addition to the distinguishing vegetative characters, the corolla of *Cremosperma pusillum* is nearly salverform with an erect posture relative to the calyx (Fig. 2C). The corolla of *Cremosperma verticillatum* has a distinct throat rendering it infundibular with an oblique posture relative to the calyx (Fig. 1C).

Distribution and habitat.—*Cremosperma verticillatum* is currently only known from one population from the Mindo Loma Cloud Forest Bird Lodge that is owned by the Herrera family. The 7.5-hectare reserve was established by the late Ing. (=Ingeniero or Civil Engineer) Hernan Boris Herrera J. (1945–2009) and is currently run by his two sons (Patricio and Boris), daughter (Gabriela) and wife (Martha Vallejo G.). The collection by Jameson in 1856 could be from the same area as the type locality for *Cremosperma verticillatum*. Many 19th century collections from the Pichincha province were simply listed as Mt. Pichincha.

Etymology.—The new species is named in reference to the presence of whorled leaves (Fig. 1A).

Conservation and IUCN Red List category.—*Cremosperma verticillatum* has not been found in any formally protected area in Ecuador and it is not known from neighboring protected areas where the first author has done extensive fieldwork (e.g., Maquipacuna, Pahuma, Los Cedros, and the environs of Mindo). According to the IUCN Red List criteria (IUCN 2001) the limited geographic range (B2a, less than 10 km^2 and known to exist at only a single location) and the small size (7.5 hectares) of the privately owned Mindo Loma Cloud Forest Bird Lodge, qualify *Cremosperma verticillatum* for being listed in the category CR (Critically Endangered).

Additional Specimens Examined. **ECUADOR. Provincia Pichincha:** canton San Miguel de los Bancos, Sendero Cascada, Mindo Loma Cloud Forest Reserve, km 73.5 via Calacali-La Independencia (3 km past the entrance to the village of Mindo), 0°0'44"S, 78°44'29"W, 1800 m, 25 May 2009, *J.L. Clark & P. Herrera 10912* (BRIT, CAS, K, MO, NY, QCNE, SEL, UNA, US); 23 May 2011 *J.L. Clark & C. Aulestia 12200* (BRIT, CAS, K, MO, NY, QCNE, SEL, UNA, US).

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It should be noted that the founder of the Mindo Loma Cloud Forest Bird Lodge, Ingeniero Hernan Boris Herrera J., was an important advocate for the conservation of Ecuador's biodiversity, and he was the Advisor for the Development Secretary of Ecuador's Ministry of Defense. He was present on the landing strip and made a last-minute decision to recuse himself from joining the 1993 fatal plane crash that ended the lives of Alwyn Gentry, Theodore A. Parker, and Eduardo Aspiazu. Together these three biologists were pioneers in the conservation of Ecuador's biodiversity. Hernan Herrera's legacy is the Mindo Loma Cloud Forest Bird Lodge. Thanks are due to the Herrera family for their conservation efforts in preserving the only currently known extant population of *Cremosperma verticillatum* inside the boundaries of the Mindo Loma Cloud Forest Bird Lodge.

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A NEW SPECIES OF *PENTAGONIA* (RUBIACEAE: HIPPOTIDEAE) FROM SOUTHERN PERU

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ABSTRACT

Recent floristic exploration in the Madre de Dios River basin and its tributary the Los Amigos River in southern Peru has continued the discovery of Rubiaceae species new to science, including the new species described here. *Pentagonia australis* C.M. Taylor & Janovec (Hippotideae) is distinguished by the combination of its subsessile leaves that are truncate to rounded at the base, its well developed and regularly lobed calyx limbs, and its tubular yellow corollas with short lobes. Also corolla form and size are detailed for the first time for two similar species found in Peru, *P. microcarpa* L. Andersson & Rova and *P. pachiteana* Cornejo.

RESUMEN

Recientes exploraciones florísticas en la región del río Madre de Dios y su tributario el río Los Amigos en el sur del Perú han contribuido al descubrimiento de especies de Rubiaceae nuevas para la ciencia, incluida la especie descrita a continuación. *Pentagonia australis* C.M. Taylor & Janovec (Hippotideae) se distingue por la combinación de las hojas subsésiles con la base truncada a redondeada, el limbo del cáliz bien desarrollado y regularmente lobado, y la corola tubular de color amarillo con lobos cortos. Ademas la forma y tamaño de la corola se describe por primera vez para dos especies similares que se hallan en Perú, *P. microcarpa* L. Andersson & Rova y *P. pachiteana* Cornejo.

KEY WORDS: Rubiaceae, *Pentagonia*, Hippotideae, Peru, IUCN Red List

INTRODUCTION

The neotropical genus *Pentagonia* Benth. (Rubiaceae: Hippotideae) comprises about thirty to forty species of shrubs and small trees, most with quite large leaves, found at low to montane elevations from Guatemala to western Brazil and central to southern Peru (Taylor 2002; Andersson & Rova 2004). *Pentagonia* is distinguished by its robust and sometimes rather succulent habit; its well developed interpetiolar stipules that are triangular and twisted in bud; its leaves with the secondary veins evident but the higher order venation inconspicuous and the surfaces finely striate due to a network of fibers (Rova & Andersson 1995); its axillary, capitate to cymose inflorescences; its relatively large, fleshy and fibrous, five-merous, bisexual flowers; its corollas with a well developed tube and valvate lobes; and its rather leathery, two-locular, berry-like fruits with numerous angled seeds on axile placentas. *Pentagonia* belongs to the small neotropical tribe Hippotideae (Rova & Andersson 1995) and is notable in the Rubiaceae for its several species with deeply pinnatifid to rarely partially pinnate leaves (e.g., *P. tinajita* Seem.). It is also unusual in its floral biology, described by McDade (1986). The flowers are protandrous and are wholly staminate at first, with the stigmas held below the anthers with their receptive surfaces pressed together. The arrangement of the androecium is unusual in *Pentagonia* because the anthers are oriented at 90° to the longitudinal axis of the corolla, and are positioned asymmetrically all on the lower side of the corolla near the middle of its tube and at slightly different levels due to differences in filament lengths as well as the bending of some of the filaments. After anthesis the style elongates to position the stigmas just below the anthers, and the stigmas separate to expose the receptive surfaces. *Pentagonia* has not

been studied as a whole and most of its individual species are also not well known. These plants often have an unbranched, monocaul (i.e., "pole") habit, which together with their unusually large leaves (up to 200 × 120 cm on petioles up to 30 cm long, e.g., *P. grandiflora* Standl.) makes the collecting of museum specimens difficult; extensive field observations are still needed to understand this genus. Taylor (2002) reviewed characteristics and taxonomy of *Pentagonia* in some detail and six additional species have been individually described (Cornejo 2006, 2009, 2010; Taylor & Gereau 2010), but the genus has not yet been comprehensively reviewed or studied.

The identification of the specimens included in the new species described below was complicated by lack of information in the published descriptions of the flowers of two other *Pentagonia* species also found in Amazonian Peru, *P. microcarpa* L. Andersson & Rova and *P. pachiteana* Cornejo. Flowering specimens of both of these species and additional fruiting specimens of *P. pachiteana* are now available, and updated morphological descriptions are presented here for those species. Also newly documented here is the occurrence of *P. pachiteana* in western Brazil.

The new species described below was discovered among specimens made by the Andes to Amazon Biodiversity Program of the Botanical Research Institute of Texas during exploration of the Madre de Dios River basin and its tributary, the Los Amigos River. This is a region of lowland Amazonian tropical to subtropical forest and wetlands in southern Peru that is not well known to science. As part of the southwestern Amazon Basin, this region contains what is probably the largest and least disturbed area remaining of upper Amazonian and lower Andean ecosystems (Foster et al. 1994), including moist, semi-deciduous tropical to subtropical forest and wetlands dominated by *Mauritia flexuosa* L.f. (Arecaceae) in the lowlands and premontane forest of the Andean foothills (Householder et al. 2010). The region is marked by a distinct four- to five-month dry season (June through September or October) and receives 2,000–2,900 mm of rain annually (Gentry & León 1997). It has been widely recognized as an important center of biological diversity, with world record numbers of birds, tabanid flies, tiger beetles, damselflies, dragonflies, and butterflies (Stewart 1988). Threats to preservation of the forest occur in the form of hunting, gold mining, timber extraction, road construction, and slash and burn agriculture, but fortunately a large system of protected areas exists in the region, including Manú and Bajuaje-Sonene National Parks and the Los Amigos Conservation Concession.

METHODS

Descriptions follow the format used by Taylor and Gereau (2010) and Taylor (2002), and as in those works morphological terms follow Lawrence (1951). Measurements given below in the technical descriptions indicate length unless otherwise indicated. The species are treated in alphabetical order. Additional collection data for the specimens cited here and high-resolution digital images of several of them are available on the Internet and can be accessed by either the species name or the collector and collection number: for the newly described species at http://atrium.andesamazon.org, and for the previously described *Pentagonia* species at www.tropicos.org.

Conservation Status Assessment Methodology.—The study presented here is taxonomic and floristic. The objectives are enumeration of the species that occur in the area of tropical Central and South America, and taxonomy of the species that belong to this genus of Rubiaceae. The methods employed here correspond only to these objectives, thus this study is based on survey of specimens collected over a number of years using varied survey methods aimed at various objectives. The specimens here used to delineate the geographic range and commonness of this new species were located through a non-exhaustive survey of several herbaria, and no field studies have been done targeting the occurrence of this species where it is known or expected to grow. Thus the floristic information presented here is a simplified presence report based on incomplete survey of the available data, which are uneven and incomplete for this region (Schulman et al. 2007). Knowledge of the true geographic range and the population size and dynamics of a species are essential for understanding the threats to its existence, and thus to understanding its actual conservation status. Documentation of the existence of a species based on one or several museum collections does not provide adequate data to evaluate these factors.

A conservation assessment is provided for the new species treated here using IUCN categories and crite-

ria (IUCN 2001) based on the totality of our current knowledge. The basis for these assessments in the form of a map and the calculated assessment parameters are available under the corresponding species name at http://www.tropicos.org (assessment parameters for the map can be seen using "Show Detail"). The species distribution was mapped in ArcView GIS 3.2 (ESRI 1999), with the grid cell size used for calculating Area of Occupancy (AOO) set at the maximum allowable value of 3.16 km (IUCN Standards and Petitions Working Group 2008); because there were only two collecting points, the IUCN Rating tool (Moat 2007) could not be used. This assessment is not being submitted to IUCN for publication on the Red List (http://www.iucnredlist.org), and the basis for this assessment should be carefully evaluated by the reader.

TAXONOMY

Pentagonia australis C.M. Taylor & Janovec, sp. nov. (**Fig. 1**). TYPE: PERU. MADRE DE DIOS. Prov. Manú: Los Amigos Biological Station, Madre de Dios River, ca. 7.0 km upriver from mouth of Río Los Amigos, Trocha Playa 25 m, 12°30'S, 70°02'W, 250 masl, 24 Jun 2003, *A.P. Maceda 723* (HOLOTYPE: USM; ISOTYPE: BRIT-06486).

Haec species a *Pentagonia microcarpa* L. Andersson & Rova foliis ad basem angustioribus atque corolla tubulari flava lobis multo brevioribus distinguitur.

Shrubs and small trees to 2.5 m tall, unbranched; main stems rather stout, quadrangular or somewhat flattened to subterete, glabrous. **Leaves** opposite; blade obovate to broadly obovate, 36–61 × 14–18 cm, drying papery to stiffly papery, adaxially glabrous, abaxially glabrous or sometimes puberulous to densely strigillose on principal veins, tapering for basal 2/3, at base 1.5–2.2 cm wide and abruptly rounded to truncate; secondary veins 16 to 19 pairs; **petioles** 0.1–0.5 cm, glabrous; **stipules** triangular, 33–40 mm, adaxially sericeous, acute, deciduous. **Inflorescences** capitate to subcapitate, sessile, with 4 to 8 flowers; bracts narrowly ligulate to elliptic-oblong, 7–15 mm, obtuse to rounded, glabrous except margins sericeous. **Flowers** sessile or subsessile; ovary portion slenderly ellipsoid, ca. 4 mm, sericeous; **calyx** limb yellow to red, externally sericeous, internally glabrous, regularly lobed, tubular portion cylindrical, 5–6 mm, lobes 5, ligulate to narrowly ligulate, 6–8 mm, obtuse to rounded, with margins sericeous; **corolla** yellow or yellowish green, tubular, externally densely sericeous, internally glabrous, tube ca. 19 mm, at middle ca. 2 mm diam., 2–2.5 mm diam. at mouth, lobes 5, narrowly triangular, 3–3.5 mm, acute; **anthers** narrowly oblong, 2–3 mm, positioned just above middle of tube and all on one side, overlapping but at different heights; **style** ca. 9 mm, **stigmas** narrowly oblong, ca. 2 mm. **Fruit** subglobose, yellow, 0.9–1.2 cm diam., sparsely strigillose to glabrescent, densely beset with small lenticels; seeds not seen.

Habitat, Distribution, and Phenology.—This species is known from moist, seasonally inundated, semideciduous floodplain forests at an elevation of ca. 270 m in the region of the confluence of the Los Amigos and Madre de Dios Rivers in Madre de Dios, southeastern Peru. Apparently it grows on sandy soil mosaics and perhaps near springs and small streams overlying rich, alluvial, floodplain forest soils. In some years it may withstand one to two months or more of 50–150 cm inundation during the peak rainy season (December through February). It has been collected in flower and fruit in May and June, on some plants simultaneously, which corresponds to the early dry season.

Conservation Assessment.—With a very small Area of Occupancy (AOO), this species meets the geographic range criterion for Endangered. Although its two known localities are from within the Los Amigos Conservation Concession, the species has not been documented from the less vulnerable national protected areas in the region (Manú National Park, Tambopata Reserved Zone, and Bajuaje-Sonene National Park). Because plants of *Pentagonia* are physically difficult to make into museum specimens and not always collected in botanical surveys, this species is very possibly more common than the limited number of specimens suggests. However it seems highly improbable that further collections will demonstrate an AOO exceeding 500 km^2, the upper threshold for the Endangered category. With a limited number of collection localities and a continuing decline in the quality of habitat in the floodplain forests of the Madre de Dios River basin due to illegal and mechanized gold mining (Swenson et al. 2011), this species is here evaluated as Endangered: EN B2ab(iii).

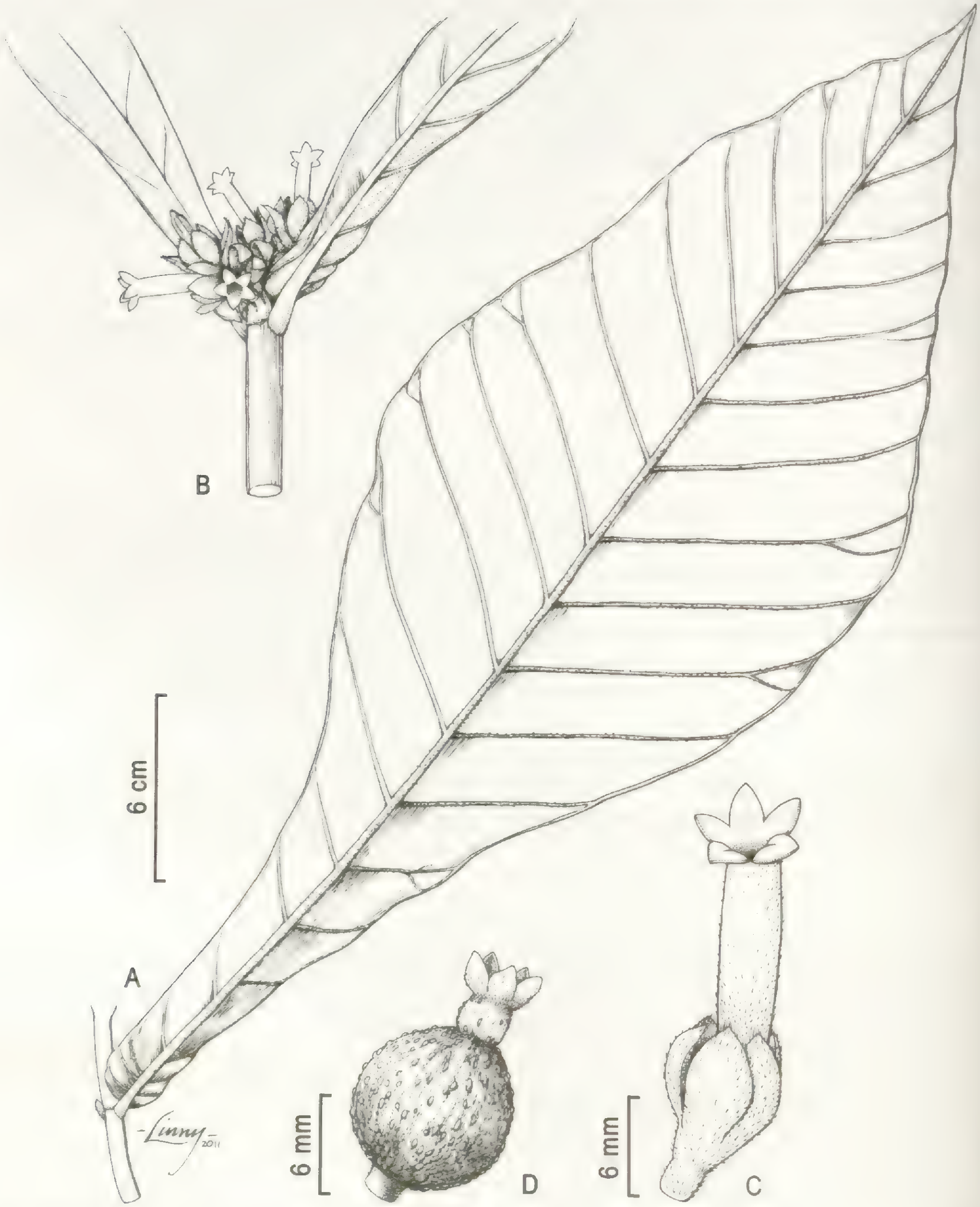

Fig. 1. *Pentagonia australis* C.M. Taylor & Janovec. A, Portion of stem with leaf. B, Inflorescence. C, flower at anthesis. D, Fruit. A, B based on *Maceda 1369* (BRIT); C, D based on *Maceda 723* (BRIT). Artist: Linny Heagy.

This new species can be recognized within *Pentagonia* by the combination of its subsessile or only very shortly petiolate leaves, with the blade glabrous on the lower surface and narrowed from above the middle to its base, and then abruply truncate to rounded at the base; its sessile, capitate or subcapitate inflorescences with yellow or yellow-green flowers; its calyx limb that is regularly lobed; its corollas with the tube cylindrical and

the lobes relatively short; and its rather small fruits. This new species is found to the south of the previously documented range of *Pentagonia*, for which *P. pachiteana* previously represented the southern limit. The range of this genus is thus now extended by several hundred km, and the specific epithet of this new species refers to its relatively southern distribution. *Pentagonia australis* has floral biology similar to that described by McDade (1986).

Pentagonia australis is similar to *P. microcarpa*, discussed in more detail below. However *P. microcarpa* can be separated by its leaves that are broader at the base, 3–6 cm wide, its red to pinkish red flowers, and its larger, funnelform corollas with the tube about twice as wide at the mouth as at the middle. Also similar to this new species and discussed below is *P. pachiteana*, which can be separated from *P. australis* by its leaves that are acute to cuneate at the base with short to well developed petioles, 0.5–2 cm long, its shorter triangular calyx lobes, 2.5–4 mm long, and its funnelform corollas with the tube about twice as wide at the mouth as at the middle. Two other *Pentagonia* species with subsessile or only shortly petiolate leaves that are rounded to truncate or cordulate at the base are also found in Peru, *P. williamsii* Standl. and *P. subauriculata* Standl., but they can both be separated from *P. australis* by their spathaceous calyx limbs (i.e., completely fused in bud and splitting irregularly as the corolla emerges). *Pentagonia subsessilis* L. Andersson & Rova also has similar subsessile leaves and the calyx limb regularly lobed; however *P. subsessilis* is known only from western Ecuador and differs in its red calyx limbs with the tubular portion longer, ca. 9 mm long, and its larger white corollas, with the tube ca. 26 mm long and the lobes 8–10 mm long.

PARATYPES. **PERU. Madre de Dios. Prov. Manú:** Puerto Maldonado, Los Amigos Biological Station, Madre de Dios River, ca. 7.0 km upriver from mouth of Río Los Amigos, Trocha Playa 25 m, 12°30'S, 70°02'W, 250 masl, *A.P. Maceda 1369* (BRIT, USM); vic. trail to Cocha Lobo, 12°30'S, 70° 02'W, 250 masl, *J.P. Janovec, P. Macedo, C. Nayahuacca, & V. Yumbato 1984* (BRIT, USM).

Pentagonia microcarpa L. Andersson & Rova, Fl. Ecuador 74:37, fig. 6. 2004.

Flowers with ovary portion slenderly ellipsoid, strigillose to strigose; **calyx** limb red or pinkish red, externally sericeous, internally glabrous, regularly lobed, tubular portion 3–6 mm, lobes 5, ligulate to elliptic-oblong, 10–15 mm, acute to obtuse; **corolla** red or pinkish red, funnelform, externally glabrous, tube 22–27 mm, at middle 3.5–4 mm diam., at mouth 6–9 mm diam., lobes 5, ovate, 7–8 mm, obtuse to acute; **anthers** narrowly oblong, 2–3 mm, positioned just below middle of corolla tube and all on one side, overlapping but at different heights; **style** ca. 9 mm, **stigmas** spathulate, ca. 1.8 mm.

This species is known from Amazonian Ecuador and northern Peru (Andersson & Rova 2004). The form and sizes of the leaves, stipules, inflorescences, and fruits and the elevational range documented by more recent specimens still fall within the description and range given in the protologue. The flower measurements here are based on the two collections cited below. *Pentagonia microcarpa* has floral biology similar to that described by McDade (1986).

Selected Specimens Studied: PERU. **Loreto. Maynas Prov.:** Yanamono, Río Amazonas, *L. Hendrix 258* (MO), *R. Vásquez & N. Jaramillo 11098* (MO).

Pentagonia pachiteana Cornejo, Harvard Pap. Bot. 11:22, fig. 2. 2006.

Flowers with ovary portion slenderly ellipsoid, ca. 4 mm, strigillose to strigose; **calyx** limb green, externally sericeous to glabrescent, internally glabrescent, regularly lobed, tubular portion ca. 4 mm, lobes 5, ligulate to triangular, 2.5–4 mm, obtuse to acute; **corolla** white to greenish white, funnelform, externally sericeous to glabrous, tube 20–25 mm, at middle ca. 4.5 mm diam., at mouth ca. 8 mm diam., lobes 5, triangular, 6–7 mm, acute; **anthers** and **stigmas** not seen. **Fruits** subglobose, yellow with red spots, ca. 15 × 14 mm, strigillose to glabrescent, densely finely lenticellate; mature seeds not seen.

Initially this species was reported only from eastern Peru, where it is still apparently only known from the type collection, but it has recently been additionally documented from the adjacent state of Acre, Brazil. All the collections seen were made at 200–300 m elevation. The flower measurements given here are based on two collections, an isotype at MO and *Oliveira et al. 674* (MO); however the flower material available is quite limited,

and the flowers were not dissected. The fruit description given here is based on *Daly et al. 764* (MO) and *Daly et al. 10019* (MO).

Selected Specimens Studied: **BRAZIL. Acre. Mun. Feijó:** Rio Muru, Seringal Lancha, proprietário Sr. Antonio Francisco Ferreira, *A.R.S. Oliveira, C. Figueiredo, L. Lima, M. Silveira, D. Daly, & C. Ehringhaus 674* (MO). **Mun. Manoel Urbano:** Rio Purus, margem esquerda, Seringal Itatinga, *M. Silveira, L.A. Lima, P.A. Verraz, J. Ribamar, & E. Consuelo 1505* (MO). **Mun. Marechal Taumaturgo:** Rio Juruá, Reserva Extrativista do Alto Juruá, S of confluence with Rio Acuria & N of São João do Breu, Colocação Tapaúna, *D.C. Daly, M. Silveira, R. Saraiva, F. Walthier, & J. Gebhards 7648* (MO). **Mun. Santa Rosa:** Alto Rio Purus, left bank, Seringal Santa Helena, *D.C. Daly, H. Kunchmeister, D. Gomes da Silva, L. Lima, & E. Consuelo 10019* (MO).

ACKNOWLEDGMENTS

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BOOK REVIEW

GIL NELSON. 2011. **The Trees of Florida: A Reference and Field Guide, Second Edition.** (ISBN 978-1-56164-474-2, pbk.; 978-1-56164-475-9, pbk.). Pineapple Press, Inc., P.O. Box 3889, Sarasota, Florida, 34230, U.S.A. (**Orders:** www.pineapplepress.com; 800-746-3275). $24.95 (hbk.), 428 pp., 170 line drawings, 150 color photos, 6" × 9".

The Trees of Florida, second edition, describes/discusses more than 530 taxa of trees, up significantly from the first edition which treated 346 trees. For the more serious tree hugger, the new edition includes a key to families and genera. The short introduction includes topics on tree diversity in Florida, what is a tree, native/non-native/invasive/endangered trees, how to use the book, knowing the language (the language of botany), illustrated glossary, and finally 18 pages of dichotomous identification keys. And I like the layout making it easy to find parallel information on different taxa. Each taxon account—given after an introduction to the family that it belongs—includes common name, Latin name, color photo numbers, origin, form, leaves, flowers, fruits, distinguishing marks, distribution, and a concluding remarks section. This section may include notes on toxicity, value to wildlife, horticultural significance, and other pertinent and interesting facts.

At $24.95 you can't go wrong with this 428 page book that is filled with nice line drawings (inserted in the text adjacent to the taxon) and so many excellent color photos (grouped together in the center of the book.

Note.—The inclusion of this title in the previous issue of *J. Bot. Res. Inst. Texas* (5:1, p. 340) was inadvertently listed as the second edition but was actually the first edition. Our apology!—*Barney Lipscomb, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

TWO NEW SPECIES OF *MONOPYLE* (GESNERIACEAE) FROM NORTHERN ECUADOR

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ABSTRACT

Two new species of *Monopyle* Benth. are described from the pluvial lowland forests of northwestern Ecuador in the province of Esmeraldas. They are both locally endemic and are of conservation concern. The two species are segregated from other *Monopyle* species by axillary inflorescences and indument type. **Monopyle uniflora** J.L. Clark & Keene is distinguished by having basally appressed inflorescence bracts, glandular trichomes on the calyx, and a singular axillary flower. The densely villous indument and inflorescence of multiple flowers differentiate **Monopyle multiflora** Keene & J.L. Clark from *Monopyle uniflora*.

RESUMEN

Dos especies de *Monopyle* son descritas de los bosques de lluvia en las tierras bajas del noroeste de Ecuador en la provincia de Esmeraldas. Estas especies son endémicas locales así como de interés para su conservación. Las dos especies son segregadas de otras especies de *Monopyle* debido a sus inflorescencias axilares y tipo de indumento. **Monopyle uniflora** J.L. Clark & Keene se distingue por tener brácteas basalmente adpresas, tricomas glandulares en el cáliz, y una sola flor axilar. El indumento densamente velloso y la inflorescencia con flores múltiples diferencian **Monopyle multiflora** Keene & J.L. Clark de *Monopyle uniflora*.

KEY WORDS: *Monopyle*, Gesneriaceae, Systematics, Ecuador

INTRODUCTION

The family Gesneriaceae is a basal lineage in the order Lamiales, with a hypothesized origin of ~ 65 million years ago (Bremer et al. 2004). The family comprises approximately 3,500 species in 150 genera, with a significant proportion being epiphytes (Weber 2004). The Gesneriaceae can be distinguished, from other families in the Lamiales, by a suite of characters including reduced pair-flowered cymes, five-lobed corollas, parietal placentation, and presence of endosperm. Some of these traits, however, are variable within the family and found in other closely related families (Weber 2004).

The Gesnerioideae is the largest subfamily of Gesneriaceae in the Neotropics with approximately 50 genera and 1,500 species (Weber 2004). The subfamily is neotropical in distribution and recognized by having isocotylous seedlings (Burtt & Wiehler 1995). The most current circumscription of the tribes (Roalson et al. 2005) further divides the Gesnerioideae into seven tribes, including Beslerieae, Gesnerieae, Sinningieae, Gloxinieae, Napeantheae, Episcieae, and Sphaerorhizeae. The Gloxinieae is characterized by having "scaly" rhizomes, a feature separating it from other tribes in the subfamily. These "scaly" rhizomes are modified underground stems with reduced succulent leaves that allow the plants to survive through periods of drought (Kvist & Skog 1992).

Monopyle Benth. (Gloxinieae: Gesneriaceae) is a genus of neotropical terrestrial understory herbs, comprising over 20 species (Weber 2004). These plants are distributed from Guatemala southward through northern South America. The genus was revised for South America by Morton (1945), but limited material was examined and he doubted some of his own determinations. The genus is characterized morphologically by anisophyllous opposite leaves, campanulate flowers, and the presence of uncinate trichomes (Roalson et al. 2005; Weber 2004). Preliminary investigations, by the first author, of *Monopyle* for a revisionary work show that these characters along with indument type, density, and inflorescence architecture are diagnostic for the genus. We focus here on the description of two new species with axillary inflorescences that are morphologically

similar to *Monopyle sodiroana* (Keene, unpublished data). These taxa have been misplaced within *Monopyle sodiroana* and are here segregated from that species. A distribution map (Fig. 3), a table of characters (Table 1), figures of five live collections, and a dichotomous key are provided to distinguish the newly described taxa.

Monopyle multiflora Keene & J.L. Clark, sp. nov. (**Figs. 1 & 2; Table 1**). TYPE: ECUADOR. ESMERALDAS: Cantón San Lorenzo, Parroquia Santa Rita, Tundaloma Lodge, km 17 Hwy San Lorenzo–Ibarra, Sector Calderón, 01°10'59"N, 78°45'3"W, 31 m, 29 May 2008, *J.L. Clark, B. Bisvicuth, S. Ginzbarg, & J. Melton 10407* (HOLOTYPE: US; ISOTYPES: K, MO, NY, QCNE, SEL).

Species nova Monopyles a speciebus aliis axillaribus multifloris inflorescentiis, villosis trichomatibus in abaxialibus foliorum lateribus, et absentia glandulosorum trichomatum in inflorescentiis differt.

Terrestrial or **epiphytic herb,** roots fibrous, shoots dorsiventral, ca. 60 cm tall, densely villous with long straight trichomes intermixed with minute uncinate trichomes throughout; lateral shoots absent in the axils of leaves. **Leaves** opposite, strongly anisophyllous; larger leaf with petioles 8–12(–18) mm long (length decreasing towards stem apex), pubescence same as above; lamina asymmetrical elliptic to ovate, base oblique, apex acuminate, (8.7–)10.5–15.9 × 3.3–7.8 cm, base entire becoming shallowly serrate to deeply serrate towards apex; adaxially dark green to maroon, sparsely villous with long straight trichomes, abaxially maroon, dense puberulent uncinate trichomes intermixed with long straight trichomes (mostly on the veins); smaller leaf with petioles 4(–9) mm long, some appearing sessile, densely villous with long straight trichomes intermixed with minute uncinate trichomes; lamina orbicular to ovate, base subequilateral to oblique, apex acuminate to cuspidate, 1.0–3.4(–5) × (0.70–)1.1–2.7(–3.4) cm, entire to serrate; adaxially densely puberulent with minute uncinate trichomes intermixed with long straight trichomes; abaxially same as larger opposite leaf. **Inflorescence** axillary with two or more flowers per axil; peduncles 1–2 mm long, densely villous with long straight trichomes intermixed with minute uncinate trichomes, floral bracts, 1.6 × 0.8 mm not basally appressed on the peduncle, persistent, opposite, adaxially densely villous, abaxially sparsely villous; pedicel to 2.8 mm long, villous with long straight trichomes intermixed with uncinate trichomes. **Calyx** green to maroon, lobes five, 6.0–10(–13) × 0.7–2(–4) mm, connate 2–3(–6) mm from base, apex acuminate, abaxially villous with long straight trichomes intermixed with minute uncinate trichomes, adaxially few long straight trichomes. **Corolla** white with yellow patch at the base of the throat, 18.3 × 9.6 mm, villous with long straight trichomes intermixed with uncinate trichomes on the outer surface, short gland-tipped papillae on the inner surface of the tube confined to the yellow patch at the base of the throat; limb glabrous, upper lobes 6.1 × 5.3 mm, lower lobe to 11 mm wide and always significantly wider than upper lobes. **Androecium** four stamens, didynamous, anthers connivent for 1.4 mm. **Nectary** usually absent, some flowers with small amounts of raised tissue dorsally at the base of the ovary. **Gynoecium** ovary half-inferior, to 2 mm wide, sparsely pubescent with minute uncinate trichomes, style to 4 mm long, sparsely pubescent with minute uncinate trichomes, stigma stomatomorphic. **Fruits** 7–10 × 3–5 mm, accrescent, dehiscing along dorsal surface, calyx persistent in fruit; seeds numerous, oblong, with tubular and bell-shaped protuberances, 0.6 × 0.4 mm, dark brown to black.

Phenology.—Collected in flower and fruit in May and September.

Distribution and Ecology.—*Monopyle multiflora* has been collected from areas noted on herbarium labels as tropical humid forest and transitional montane/premontane to lowland wet forest. It is also noted to be growing in the understory of the following canopy trees: *Carapa guianenesis* Aubl. (Meliaceae), *Humiriastrum procerum* (Little) Cuatrec. (Humariaceae), *Jacaranda copaia* (Aubl.) D. Don (Bignoniaceae), and *Jessenia bataua* (Mart.) Burret. This species is known from the Esmeraldas province in Ecuador. It is likely that additional populations will be discovered near the type locality in pluvial forests in adjacent Colombia where limited fieldwork has been conducted.

Conservation and IUCN Red List category.—*Monopyle multiflora* is known from two populations in the Esmeraldas province along the foothills of the eastern Andean slopes of northern Ecuador (Fig. 3). The type collection was made in Tundaloma Lodge, a small private reserve located 17 km east of the town San Lorenzo (sector Calderón) in northern Ecuador. The Tundaloma Lodge is owned and managed by Andres Chiriboga and it is a destination for bird watchers. Most of the forest along the San Lorenzo-Ibarra highway has been converted to African Palm plantations as a result of the recent completion of the highway. Some patches of

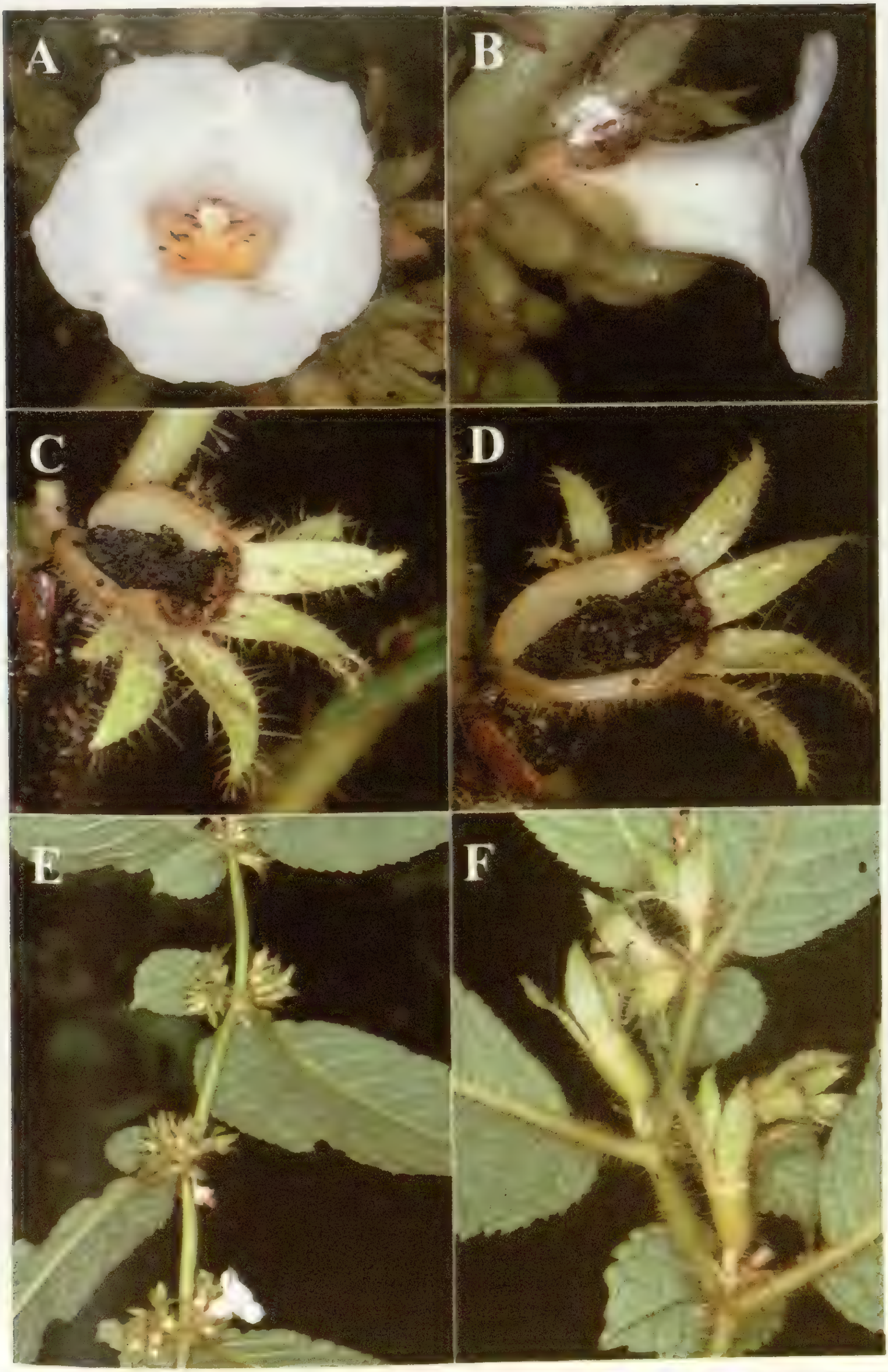

FIG. 1. *Monopyle multiflora*. **A.** Face view of flower (yellow patch). **B.** Lateral view of flower. **C & D.** Mature fruit. **E.** Habit showing strongly anisophyllous leaves. **F.** Immature Fruits (Photos by J.L. Clark; voucher from the holotype: *J.L. Clark, B. Bisvicuth, S. Ginzbarg & T. Melton 10407* at US).

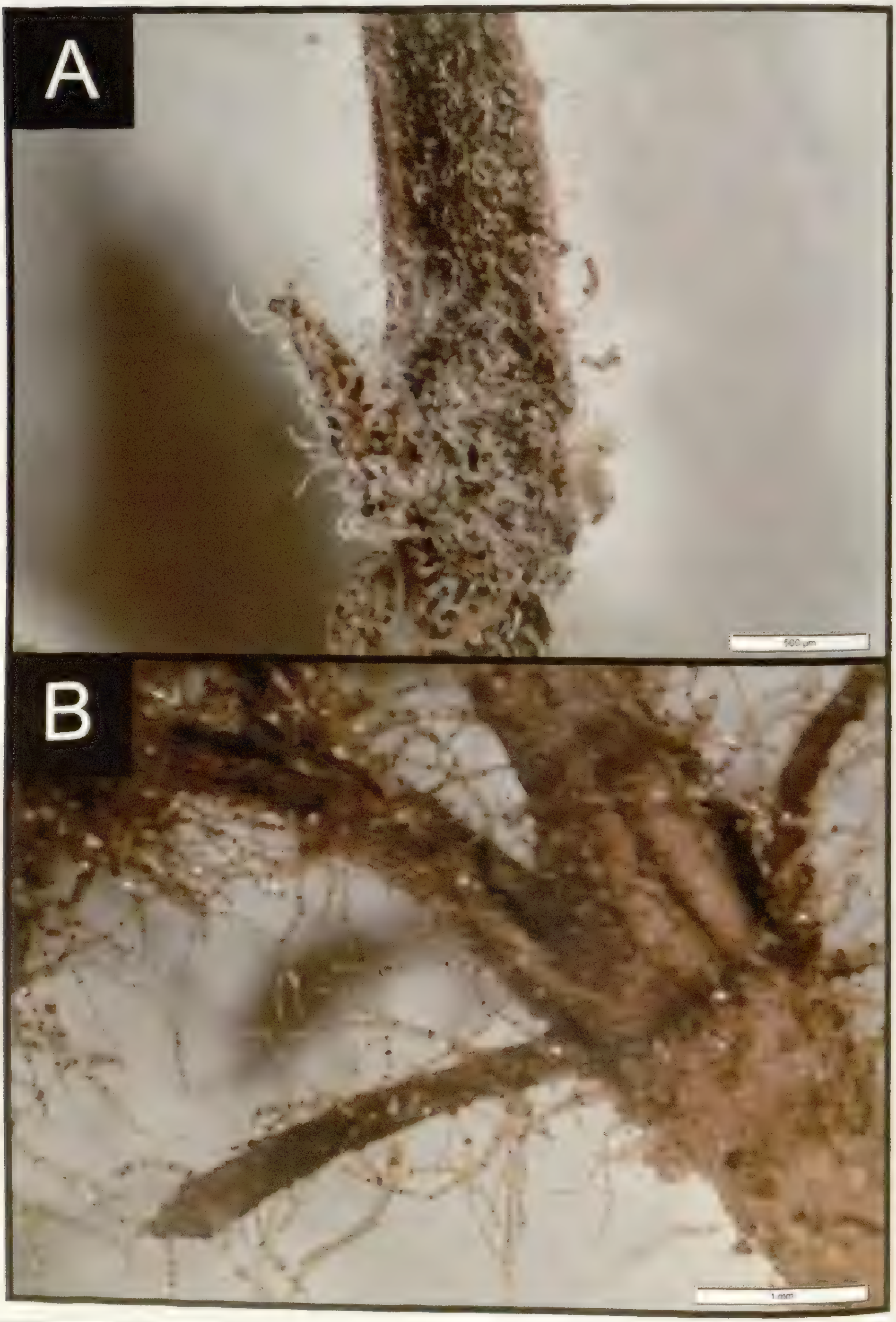

FIG. 2. A. *Monopyle uniflora* showing peduncle with basally appressed bracts (voucher from holotype: *J.L. Clark & Gesneriad Research Expedition Participants 11162* at US). B. *Monopyle multiflora* showing peduncle with the bracts not basally appressed. (Photos by Jeremy Keene; voucher from the holotype: *J.L. Clark, E. Bisvicuth, S. Ginzbarg, & J. Melton 10407* at US).

TABLE 1. Main diagnostic features between *Monopyle multiflora*, *M. uniflora*, and *M. sodiroana*.

Diagnostic character	*Monopyle multiflora*	*Monopyle uniflora*	*Monopyle sodiroana*
Glandular trichomes on the calyx	Absent	Present	Absent
Stem indument	Villous	Puberulent	Puberulent
Inflorescence	Axillary	Axillary	Terminal
Inflorescence bract base	Not appressed	Appressed	Not appressed

isolated forest exist in the hilly areas along the highway, but the habitat that is most threatened is the lowland flat areas near San Lorenzo where *Monopyle multiflora* is located. It is not found in any formally protected area in Ecuador and additional fieldwork in adjacent forests in Colombia may result in the documentation of additional populations. According to the IUCN Red List criteria (IUCN 2001) for limited geographic range (B2a, less than 10 km^2 and known to exist at only a single location) and considering the uncertain future of habitat conservation along the San Lorenzo-Ibarra highway, *Monopyle multiflora* should be listed in the category CR (Critically Endangered).

Etymology.—The specific epithet, *multiflora*, reflects the species typically having many flowers per axillary inflorescence.

PARATYPES. **ECUADOR. ESMERALDAS:** Entre el Estero Molina–Hcda. Montero Riera [between the Molina stream and the Montero Riera Farm], San Marco, 140 m, 7 Sep 1991, *J. Jaramillo, E. Grijalva & M. Grijalva 13811* (NY).

Monopyle uniflora J.L. Clark & Keene, sp. nov. (**Figs. 2 & 4; Table 1**). TYPE: ECUADOR. ESMERALDAS: Cantón San Lorenzo, flat forest near highway Ibarra–San Lorenzo, near Rio Durango, Centro de Manejo Lote #1 (Fundacion Sirua), Sendero Hola, 1°5'5"N, 78°41'12"W, 87 m, 4 Jun 2009, *J.L. Clark & Gesneriad Research Expedition Participants 11162* (HOLOTYPE: US; ISOTYPES: K, MO, QCNE, SEL).

Species nova *Monopyles* a speciebus aliis axillaribus inflorescentiis singulari flore cum amplectenti bractea, et praesentia uncinatorum et glandulosorum trichomatum in inflorescentiis differt.

Terrestrial herb, roots fibrous, stems dorsiventral to erect, 40–80 cm tall, puberulent with loosely appressed uncinate trichomes throughout, green with some red coloration. **Leaves** opposite, strongly anisophyllous; larger leaf with petioles 5.1–15.9 mm (length decreasing towards apex), densely puberulent with short uncinate trichomes intermixed with scattered long straight trichomes; lamina elliptic to falcate, base oblique, apex falcate-acuminate, 5.6–8.5(–14.2) × (2.5–)3.4–6.7 cm, shallowly serrate to deeply serrate towards apex; adaxially dark green, sparsely puberulent with minute uncinate trichomes intermixed with scattered long straight trichomes, abaxially light green, minute uncinate trichomes (mainly on the veins); small leaf with petioles 1.6–4.6 mm, dense puberulent uncinate intermixed with long straight trichomes; lamina orbicular to ovate, base subequilateral to oblique, apex cuspidate, (1.0–)1.9–2.8(–5.5) × 3.3–4.9 cm, serrulate to serrate; adaxially bullate, evenly spaced minute uncinate trichomes intermixed with sparse long straight trichomes; abaxially sparse to somewhat dense puberulent uncinate trichomes. **Inflorescence** axillary, a reduced pair-flowered cyme with one to two flowers; peduncles 0.9–2.1 mm, puberulent with uncinate trichomes, bracts 1.1–1.3 mm × 0.4 mm appressed basally on the peduncle, persistent, opposite, sparsely to densely villous; pedicel 2.2–4.5 mm, puberulent with uncinate trichomes intermixed with long glandular trichomes. **Calyx** light green, lobes five, equal, 5.1–6.3 × 0.9–1.7 mm, connate 1.8–2.4 mm from base, apex acuminate, puberulent with uncinate trichomes intermixed with long straight glandular and non-glandular trichomes, adaxial surface with few long straight trichomes. **Corolla** white to light lavender with broad yellow patch in the base of the throat, 14.8–17.3 × 7.2–10 mm, sparsely pubescent with short sharply pointed trichomes on the outer surface, short gland-tipped papillae confined to the yellow patch on the inner surface of the tube; limb glabrous, upper lobes 5–7 × 7–9 mm, lower lobe to 13 mm long, always significantly wider than upper lobes. **Androecium** with four stamens, didynamous, anthers connivent for 1.1 mm. **Nectary** usually absent, some flowers with small amounts of raised tissue at base of ovary. **Gynoecium** ovary half-inferior, to 1.6 mm wide, puberulent with uncinate trichomes, style to 4 mm long, sparsely pubescent with uncinate trichomes, stigma stomatomorphic. **Fruits**

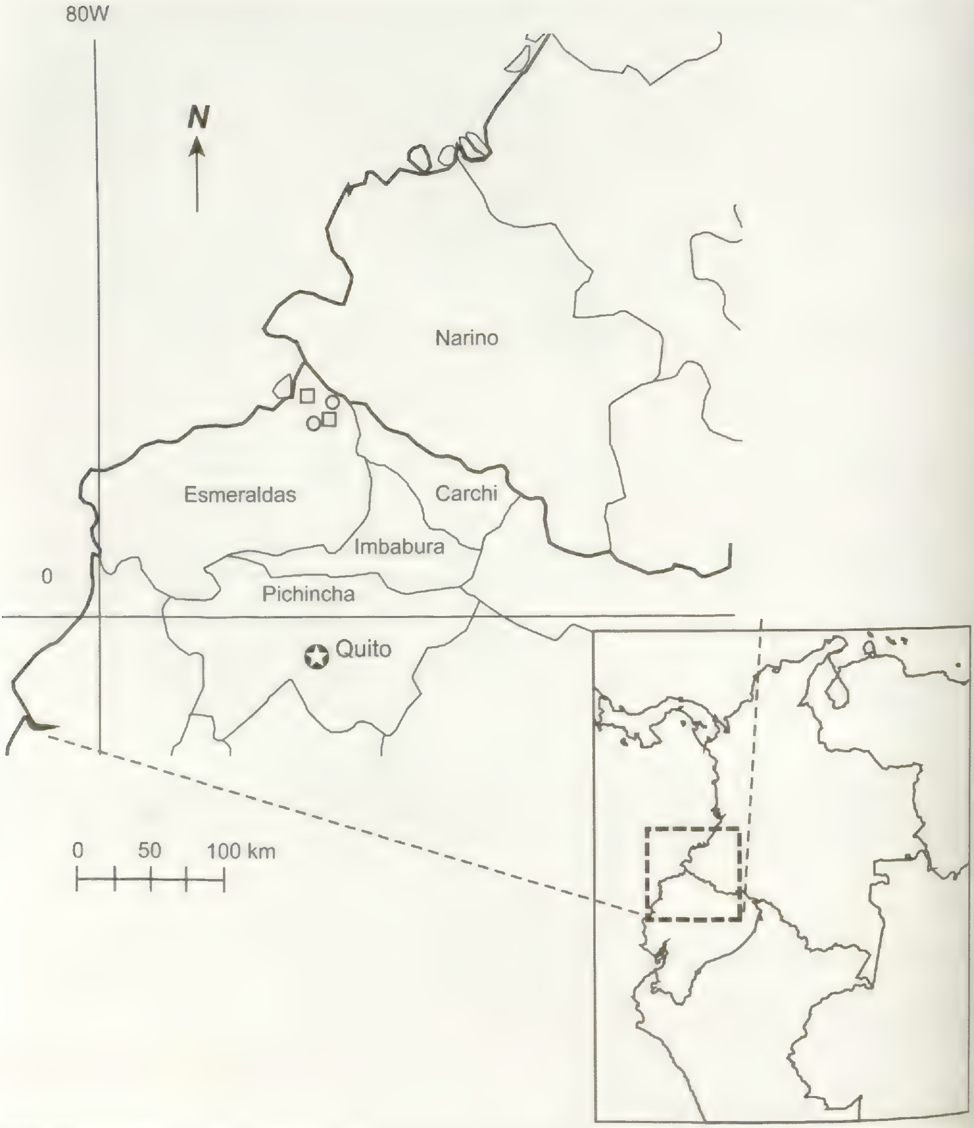

Fig. 3. Distribution map of *Monopyle uniflora* (open circle) and *Monopyle multiflora* (open square).

6–9 × 2–4 mm, accrescent, dehiscing on dorsal side only, calyx persistent in fruit; seeds numerous, oblong, with tubular and bell-shaped protuberances, 0.4 × 0.2 mm, cream to light tan.

Phenology.—Collected with flowers and fruits in June and October.

Distribution and Ecology.—*Monopyle uniflora* has been collected from areas noted as flat forest and humid tropical primary forest on herbarium labels. It is likely that additional populations will be discovered near the type locality in pluvial forests in adjacent Colombia where limited fieldwork has been conducted.

Conservation and IUCN Red List category.—*Monopyle uniflora* is known from two collections in the Esmeraldas province along the foothills of the eastern Andean slopes of northern Ecuador (Fig. 3). The type

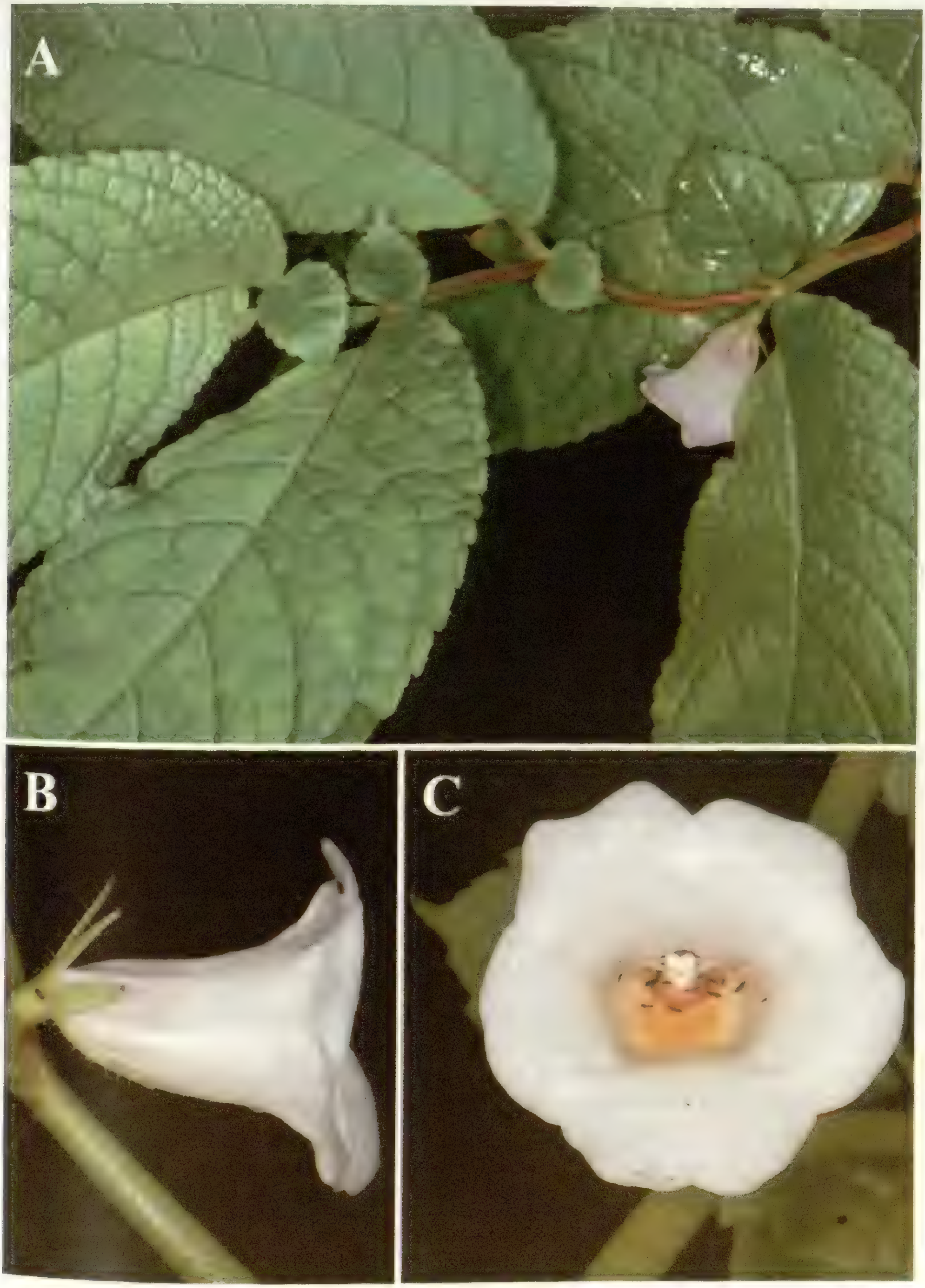

FIG. 4. *Monopyle uniflora*. **A.** Habit showing strongly anisophyllous leaves and single axillary flower. **B.** Lateral view of Flower. **C.** Front view of flower showing yellow patch at base of tube (Photos by J.L. Clark; voucher from the holotype: *J.L. Clark & Gesneriad Research Expedition Participants 11162* at US).

collection is from a remnant patch of lowland flat forest that is managed by Fundacion Sirua, a foundation dedicated to the conservation of biodiversity along the Ibarra–San Lorenzo highway. According to the IUCN Red List criteria (IUCN 2001) for limited geographic range (B2a, less than 10 km^2) and considering the uncertain future of habitat conservation along the San Lorenzo-Ibarra highway, *Monopyle uniflora* should be listed in the category CR (Critically Endangered).

Etymology.—The specific epithet, *uniflora*, comes from the species typically producing a single flower per axillary inflorescence.

PARATYPES: **ECUADOR. ESMERALDAS:** San Lorenzo Cantón, Reserva Etnica Awá, Centro Ricaurte, 01°10'N, 78°32'W, 300 m, 27 Oct 1992, *G. Tipaz, C. Aulestia, & M. Pascal 2218* (MO, QCNE, US).

KEY TO DIFFERENTIATE NEW SPECIES FROM *MONOPYLE SODIROANA*

1. Inflorescences terminal ____ **Monopyle sodiroana**
1. Inflorescences axillary.
   2. Calyx with glandular trichomes and bracts basally appressed ____ **Monopyle uniflora**
   2. Calyx lacking glandular trichomes and bracts not basally appressed ____ **Monopyle multiflora**

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ESTUDIOS EN LAS APOCYNACEAE NEOTROPICALES XLII: SINOPSIS DEL GÉNERO *MANDEVILLA* (APOCYNOIDEAE: MESECHITEAE) EN COLOMBIA

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RESUMEN

Se presenta una sinopsis del género *Mandevilla* (Apocynoideae: Mesechiteae) en Colombia. Un total de 49 taxones son reconocidos, incluyendo la descripción de **M. nacarema** y **M. puyumato.** Una clave para las especies, taxonomia y sinonimia es brindada para cada taxón, incluyendo la descripción de sus afinidades taxonómicas. Se designan lectotipos para *Dipladenia albo-viridis* Rusby y *M. tenuicarpa* Rusby y neotipos para *M. montana* (Kunth) Markgr. var. *peruviana* Markgr. y *M. caurensis* Markgr.

PALABRAS CLAVE: Apocynaceae, Apocynoideae, Mesechiteae, *Mandevilla*, Colombia

ABSTRACT

A synopsis of the genus *Mandevilla* (Apocynoideae: Mesechiteae) in Colombia is presented. A total of 49 taxa are recognized, including two new species, **M. nacarema**, and **M. puyumato.** A key to the species, taxonomy and synonymy if given for every species, including the discussion of their interspecific relationships. Lectotypes are designed for *Dipladenia albo-viridis* Rusby, and *M. tenuicarpa* Rusby and neotypes are selected for *M. montana* (Kunth) Markgr. var. *peruviana* Markgr., and *M. caurensis* Markgr.

KEY WORDS: Apocynaceae, Apocynoideae, Mesechiteae, *Mandevilla*, Colombia

Colombia es el segundo país con mayor diversidad biológica en Sur América (superado solamente por Brasil), en el cual se tienen registradas aproximamente 28,000 especies de plantas (Rangel 2005). En el caso de la familia Apocynaceae, subfamilias Apocynoideae y Rauvolfioideae (sensu Endress et al. 2007) se reportan un total aproximado de 45 géneros y 246 especies (Morales, en prep.), siendo el género *Mandevilla* (Apocynoideae: Mesechiteae) el más numeroso.

En su contexto actual, *Mandevilla* (Apocynoideae: Mesechiteae) es un género con ca. 162 especies, de las cuales 63 pertenecen al subgénero *Exothostemom* y 99 taxones al subgénero *Mandevilla*. En los últimos años, varios estudios filogenéticos basados en indicadores moleculares y morfológicos (e.g., Simões et al. 2004, 2006) aumentaron la cantidad de especies, al reducir a la sinonimia varios géneros tratados hasta entonces como entidades diferentes (e.g., *Macrosiphonia* Müll. Arg., *Quiotania* Zarucchi, *Telosiphonia* (Woodson) Henrickson). El número total actual de especies es ligeramente mayor, dado que existen varios taxones sin describir en Sur América, principalmente en Brasil y en la Cordillera de los Andes.

La última monografía del género (Woodson 1933) reportó un total de 16 especies para Colombia. Como parte de la elaboración de un tratamiento de Apocynaceae para Colombia, se presenta una sinopsis del género *Mandevilla*. Un total de 49 taxones son reportados (15 de ellos endémicos), citando la sinonimia relevante, así como datos de distribución y un especímen representativo por departamento. Las medidas y descripción de los caracteres morfológicos citados en la clave y en la discusión de las especies afines han sido tomados de la monografía del género (Morales, sin publ.), por lo que pueden diferir de los citados anteriormente en otros trabajos previos (e.g., Woodson 1933, 1936). En la clave, los términos "generalmente" o "usualmente," indican predominancia de un caracter o de una medida, pero no su exclusividad.

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CLAVE PARA LAS ESPECIES DEL GÉNERO *MANDEVILLA* EN COLOMBIA

1. Hojas con los coléteres más o menos aglomerados en la base del nervio central; tubo de la corola usualmente recto en la base; sépalos usualmente con varios coléteres internamente, irregularmente distribuidos o en grupos alternos.
  2. Corola infundibuliforme.
    3. Láminas foliares usualmente con la base cordada a subcordada.
      4. Sépalos 3–3,5 mm de largo; lóbulos de la corola blanco-verdosos, la parte inferior del tubo 7–8 mm de largo ____ **M. albo-viridis**
      4. Sépalos 4–9 mm de largo; lóbulos de la corola morados, la parte inferior del tubo 19–31 mm de largo ____ **M. veraguasensis**
    3. Láminas foliares usualmente con la base redondeada, obtusa a cuneada.
      5. Corola con la garganta amarilla internamente, la parte inferior del tubo 10–18 mm de largo, la parte superior 17–30 mm de largo, con un diámetro de 10–20 mm en el orificio; anteras 8,5–10 mm de largo ____ **M. boliviensis**
      5. Corola con la garganta blanca, crema a blanco-verdosa internamente, la parte inferior del tubo 5–7,3 mm de largo, la parte superior 5–6 mm de largo, con un diámetro de 4–6,6 mm en el orificio; anteras 4,9–5,1 mm de largo ____ **M. riparia**
  2. Corola hipocrateriforme.
    6. Estambres insertos en la mitad distal, cerca de la boca o aproximadamente en la mitad de la longitud del tubo de la corola.
      7. Corolas con el tubo 2–3 mm de largo ____ **M. jasminiflora**
      7. Corolas con el tubo 18–22 mm de largo.
        8. Hojas con la superficie abaxial glabra; sépalos 1–1,4 mm de largo ____ **M. cercophylla**
        8. Hojas con la superficie abaxial densamente puberulenta a tomentulosa; sépalos 3–5 mm de largo ____ **M. montana**
    6. Estambres insertos en la mitad proximal del tubo, cerca de la base.
      9. Sépalos 3–4 mm de ancho, foliáceos, con la venación conspicuamente impresa; brácteas florales deciduas antes de la antésis, nunca presentes durante la antésis ____ **M. paisae**
      9. Sépalos 1–2 mm de ancho, escariosos a subfoliáceos, con la venación no evidente; brácteas florales persistentes, incluso aún despúes de caerse el pedicelo.
        10. Brácteas 5–18(–21) × 1–2 mm, subfoliáceas; lóbulos de la corola 13–22 × 3,5–5,7 mm; anteras 3–3,2 mm de largo ____ **M. pubescens**
        10. Brácteas 3–7(–8,6) × 1–1,4(–1,6) mm, escariosas; lóbulos de la corola 7,5–11 × 4,5–7 mm; anteras ca. 5 mm de largo ____ **M. bogotensis**
1. Hojas con los coléteres irregularmente distribuidos a lo largo del nervio central; tubo de la corola usualmente algo giboso en la base; sépalos con un solo coléter ubicado más o menos en el medio del sépalo (a veces abarcando el ancho basal total del sépalo).
  11. Hojas verticiladas.
    12. Hojas usualmente en verticilos de 4, láminas 1–3 mm de ancho; sépalos 1–1,4 mm de largo; corola con un diámetro 6–9 mm en el orificio ____ **M. annulariifolia**
    12. Hojas usualmente en verticilos de 3, láminas 4–9 mm de ancho; sépálos 2,5–3 mm de largo; corola con un diámetro12–13,5 mm en el orificio ____ **M. thevetioides**
  11. Hojas opuestas.
    13. Corola hipocrateriforme.
      14. Brácteas florales generalmente foliáceas, 10–42 × 2,5–5 mm.
        15. Lóbulos de la corola blancos, la garganta amarilla; láminas foliares 7–16 mm de ancho, las venas terciarias usualmente no evidentes ____ **M. aridana**
        15. Lóbulos de la corola amarillos, la garganta usualmente rojiza a anaranjada; láminas foliares 15–92 mm de ancho, las venas terciarias evidentes al menos abaxialmente.
          16. Corola muy diminuta y esparcidamente puberulenta a glabra o glabrada externamente, la pubescencia cuando presente, solo visible con aumento; inflorescencia diminutamente puberulenta a glabrada; folículos glabros ____ **M. rugellosa**
          16. Corola pilosa a pilosulosa externamente; inflorescencia densa a moderadamente pilosulosa; folículos esparcidamente hirsutos a glabrescentes ____ **M. villosa**
      14. Brácteas florales generalmente escariosas, 0,7–8 × 0,5–2 mm.
        17. Láminas foliares 2,5–7 mm de ancho; pecíolos 1–2,5 mm de largo ____ **M. colombiana**
        17. Láminas foliares 9–60 mm de ancho; pecíolos 4,5–28 mm de largo.
          18. Lóbulos de la corola blancos, algunas veces la base con tonos rojizos justo antes de la boca.
            19. Pedicelos 10–24 mm de largo ____ **M. longipes**
            19. Pedicelos 3–7,5 mm de largo.
              20. Láminas foliares 1,9–4,1 × 1,1–2,5 cm, la base cordada a levemente cordada; hojas densamente tomentulosas abaxialmente; tubo 15–22 mm de largo; ramitas jóvenes cilíndricas a subcilíndricas ____ **M. xerophytica**
              20. Láminas foliares 8,5–11 × 3,4–3,9 cm, la base sagitado-auriculada; hojas moderada a esparcidamente puberulentas abaxialmente; tubo 25–32 mm de largo; ramitas jóvenes irregularmente aplanadas y sulcadas cuando jóvenes, subcilíndricas y levemente acostilladas o anguladas cuando viejas ____ **M. antioquiana**

18. Lóbulos de la corola amarillos, rojizo-amarillos a rojizo-anaranjados.
  21. Pecíolos 13–28 mm de largo ____ **M. pavonii**
  21. Pecíolos 3–10 mm de largo.
    22. Tubo de la corola 13–15 mm de largo; el ápice del botón floral anchamente agudo a obtuso ____ **M. nevadana**
    22. Tubo de la corola 20–34 mm de largo; el ápice del botón floral agudo, agudo-apiculado o cortamente acuminado o apiculado.
      23. Láminas foliares cordadas a cordado-auriculadas basalmente; cabeza estigmática 1,8–2,2 mm de largo; inflorescencias con las flores relativamente laxamente dispuestas ____ **M. subsagittata**
      23. Láminas foliares obtusas a levemente cordado-auriculadas basalmente; cabeza estigmática hasta 1,3 mm de largo; inflorescencias con las flores relativamente densamente aglomeradas ____ **M. rugellosa**

13. Corola infundibuliforme.
  24. Brácteas florales 11–68 × 1,5–19 mm, foliáceas a subfoliáceas.
    25. Sépalos 7–18 mm de largo.
      26. Brácteas florales 44–68 mm de longitud ____ **M. megabracteata**
      26. Brácteas florales 11–35 mm de longitud.
        27. Parte superior del tubo de la corola 15–21 mm de largo; folículos libres, solo unidos en el ápice ____ **M. hirsuta**
        27. Parte superior del tubo de la corola 27–31 mm de largo; folículos fusionados a lo largo de su entera longitud ____ **M. sagittarii**
    25. Sépalos 1,8–6 mm de largo.
      28. Parte inferior del tubo de la corola 7–9 mm de largo ____ **M. lancibracteata**
      28. Parte inferior del tubo de la corola 14–36 mm de largo.
        29. Hojas con la base cuneada a redondeada ____ **M. javitensis**
        29. Hojas con la base cordada.
          30. Tallos viejos con los coléteres interpeciolares formando una línea interpeciolar conspicua y elevada (como una costilla); anteras 7,5–8,5 mm de largo ____ **M. steyermarkii**
          30. Tallos viejos con los coléteres interpeciolares inconpicuos, sin forma una línea interpeciolar elevada; anteras 3,8–4,6 mm de largo.
            31. Láminas foliares con el ápice obtuso-mucronado a redondeado-mucronado; corola con un diámetro de 14–22 mm en la boca ____ **M. bracteata**
            31. Láminas foliares con el ápice acuminado a caudado-acuminado; corola con un diámetro de 9,5–11 mm en la boca ____ **M. moritziana**
  24. Brácteas florales 1–5(–8) × 0,5–1,5(–2) mm, escariosas.
    32. Láminas foliares con las venas terciarias no impresas en la superficie abaxial.
      33. Hojas usualmente con el ápice agudo; flores sésiles; arbustos erectos ____ **M. nacarema**
      33. Hojas usualmente obtuso-mucronadas, redondeado-mucronadas a emarginado-mucronadas apicalmente; flores con pedicelos 1–1,5 mm de largo; lianas ____ **M. caquetana**
    32. Láminas foliares con las venas terciarias impresas en la superficie abaxial.
      34. Hojas con peciolos 55–135 mm de largo ____ **M. callista**
      34. Hojas con peciolos hasta 35 mm de largo.
        35. Ramitas jóvenes conpicuamente alada ____ **M. nerioides**
        35. Ramitas jóvenes nunca aladas.
          36. Hojas maduras con las venas secundarias y terciarias no evidentes ____ **M. vanheurckii**
          36. Hojas maduras con las venas secundarias y terciarias evidentes.
            37. Corola con un diámetro de 4–12 mm en la boca.
              38. Hojas usualmente más de 4 veces más largas que anchas; tallos jóvenes irregularmente acostillados longitudinalmente ____ **M. lancifolia**
              38. Hojas usualmente más de 3 veces más largas que anchas; tallos jóvenes no acostillados longitudinalmente.
                39. Hojas con la base predominantemente cordada a subcordada.
                  40. Parte superior del tubo de la corola 14–20(–26) mm de largo ____ **M. trianae**
                  40. Parte superior del tubo de la corola 8–9 mm de largo ____ **M. puyumato**
                39. Hojas con la base predominantemente aguda, obtusa a redondeada.
                  41. Parte inferior del tubo de la corola 14–16 mm de largo; láminas foliares glabras abaxialmente; pedicelos 8–12 mm de largo ____ **M. arcuata**
                  41. Parte inferior del tubo de la corola 4–9 mm de largo; láminas foliares usualmente glauco-tomentulosas abaxialmente; pedicelos 2–7 mm de largo ____ **M. schlimii**
            37. Corola con un diámetro de 14–28 mm en la boca.
              42. Hojas linear a linear-elípticas, usualmente más de 5 veces más largas que anchas ____ **M. gracilis**

42. Hojas de varias formas, pero nunca lineares, menos de 4 más largas que anchas.
 43. Hojas generalmente con la base aguda a cuneada.
  44. Venas secundarias más o menos perpendiculares en relación al nervio central; lóbulos blancos, blanco-rosados a crema ______ **M. caurensis**
  44. Venas secundarias evidentemente arcuadas en relación al nervio central; lóbulos amarillos ______ **M. cuneifolia**
 43. Hojas generalmente con la base cordada, subcordada a redondeada.
  45. Láminas foliares con domacios diminutos abaxialmente; parte inferior del tubo de la corola 9–10 mm de largo ______ **M. sancta-martae**
  45. Láminas foliares sin domacios; parte inferior del tubo de la corola 16–34 mm de largo.
   46. Sépalos usualmente 4–7 mm de largo; folículos 24,3–35,6 cm de largo; semillas 13–16 mm de largo ______ **M. symphitocarpa**
   46. Sépalos usualmente 1,5–3,5 mm de largo; folículos 3–23 cm de largo; semillas 6–12 mm de largo.
    47. Hojas con el ápice no mucronado o mucronulado, el mucrón ausente.
     48. Hojas con la base generalmente cordada a subcordada, pubescente abaxialmente; anteras 4–4,8 mm de largo ______ **M. speciosa**
     48. Hojas con la base generalmente obtusa a redondeada, glabra o glabrescente abxialmente; anteras 6–8 mm de largo ______ **M. subcarnosa**
    47. Hojas con el ápice mucronado o mucronulado, el mucrón diminuto pero evidente.
     49. Folículos moniliformes, conspicuamente articulados, con conspicuas líneas oscuras longitudinalmente; semillas 6–7 mm de largo ______ **M. mollissima**
     49. Folículos continuos o con constricciones leves, no articulados, sin líneas oscuras longitudinales; semilas 10–12 mm de largo ______ **M. scabra**

Mandevilla albo-viridis (Rusby) Woodson, Ann. Missouri Bot. Gard. 19:69. 1932. *Dipladenia albo-viridis* Rusby, Descr. S. Amer. Pl. 86. 1920. TIPO: COLOMBIA. MAGDALENA: Sierra del Líbano, 22 ene 1899 (fl), *H. Smith 1904* (HOLOTIPO: NY, perdido en 1978; LECTOTIPO, designado aquí: K [fotografía, INB]).

Distribución y hábitat.—Endémica, creciendo en bosques nubosos en elevaciones alrededor de 2000 m.

Mandevilla albo-viridis, conocida únicamente por la colección tipo, es una especie que se puede reconocer con facilidad por sus hojas cordadas a subcordadas en la base, con los coléteres aglomerados en la base del nervio central, sépalos de 3–3,5 mm de largo y corolas infundibuliformes, con la parte inferior del tubo de 7–8 mm de largo.

El holotipo de esta especie se perdió en un envío de material entre Estados Unidos y Venezuela en 1978. Por lo tanto, se selecciona como el lectotipo, el único duplicado conocido y depositado en el Herbario de Kew (K), Inglaterra.

Mandevilla annulariifolia Woodson, Bot. Mus. Leafl. 18:168–169. 1958. TIPO: COLOMBIA. VAUPÉS: río Apaporis, Cachivera de Jirijirimo, 16 sep 1951 (fl, fr), *R. Schultes & I. Cabrera 14013* (HOLOTIPO: MO; ISOTIPOS: COL, NY, US).

Distribución y hábitat.—SE de Colombia, S de Venezuela y NO de Brasil, en bosques muy húmedos y vegetación asociada con afloramientos rocosos, en elevaciones de 100–900 m.

Mandevilla annularifolia se puede reconocer fácilmente por sus hojas verticiladas (4 por nudo) y su habitat restringido a afloramientos graníticos en la cuenca baja amazónica. Existen tres especies adicionales con hojas verticiladas y aún no reportadas para Colombia (*M. filifolia* Monac., *M. benthamii* (A. DC.) K. Schum. y *M. aracamunensis* Morillo), de las cuales *M. annularifolia* se separa por sus hojas glabras, e inflorescencias sésiles o subsésiles.

Especímenes representativos examinados: **Amazonas:** río Apaporis, Jirijirimo, 25 nov 1951 (fl), *García-Barriga 13750* (COL, US). **Guainía:** Maimachi, Serranía del Naquen, Cerro Minas, 7 abr 1993 (fl), *Barbosa & Madriñán 8354* (COL, GH, MO). **Vaupés:** Mitú, río Parana-Pichuna, 18 jul 1979 (fl, fr), *Zarucchi 2492* (COAH, COL, HUA, K, MA, WAG).

Mandevilla antioquiana J.F. Morales, Anales Jard. Bot. Madrid 62:65, fig. 1. 2005. TIPO: COLOMBIA. ANTIOQUIA: Municipio Campamento, Vereda Llandas, camino a Mina Las Brisas, 7 sep 1989 (fl, fr), *R. Callejas et al. 8294* (HOLOTIPO: HUA).

Distribución y hábitat.—Endémica, creciendo en bosques húmedos premontanos en elevaciones de 1650–1850 m.

Mandevilla antioquiana se puede confundir con con *M. longipes*, ya que ambas tienen hojas morfológicamente similares y corolas blancas, pero la primera especie se reconoce con facilidad por sus pedicelos mucho más cortos (3,5–7,5 mm vs. 10–24 mm).

Especimenes representativos examinados: **Antioquia:** datos perdidos (fl, fr), *Toro s.n.* (MEDEL).

Mandevilla arcuata A. Gentry, Ann. Missouri Bot. Gard. 71:1079. 1984. TIPO: PERÚ. AMAZONAS: Valle del río Santiago, cerca de Caterpiza, 200 m, 29 ene 1980 (fl, fr), *S. Tunqui 674* (HOLOTIPO: MO; ISOTIPOS: USM, WAG).

Distribución y hábitat.—S de Colombia y Perú, creciendo en bosques muy húmedos, en elevaciones de 150–800 m.

Mandevilla arcuata se puede confundir en Colombia con *M. schlimii*, ya que ambas tienen hojas con la base usualmente cuneada a obtusa, y corola con un diámetro de 5–12 mm en la boca, sin embargo, la primera especie se puede reconocer con facilidad por sus hojas glabras abaxialmente (vs. diminuta y densamente glaucotomentulosas) y con las venas secundarias levemente impresas y las terciarias no evidentes (vs. conspicuamente impresas).

Especimenes representativos examinados: **Amazonas:** La Chorrera, río Igara-Parona, 18 jun 1874 (fl, fr), *Sastre 3399* (COL, P). **Caquetá:** Florencia, Cerro La Sardina, 30 mar 1940 (fl), *Cuatrecasas 8924* (COL, F, US).

Mandevilla aridana J.F. Morales, Candollea 60:51, f. 1. 2005. TIPO: COLOMBIA. SANTANDER: Bucaramanga, Los Cayenos, 16 oct 1977 (fl), *E. Rentería et al. 735* (HOLOTIPO: HUA; ISOTIPOS: COL, INB, MO).

Distribución y hábitat.—Endémica a Colombia, creciendo en bosques secos en elevaciones de 300–950 m.

Esta especie es algo similar a *Mandevilla rugellosa* (Rich) L. Allorge y *M. villosa* (Miers) Woodson, pero se separa por sus hojas glabrescentes (vs. pubescentes) y corolas blancas. Adicionalmente, *M. aridana* crece en bosques secos, mientras que las otras especies crecen en bosques muy húmedos.

Especimenes representativos examinados: **Santander:** Pailas, 5 km S de Pie de Cuesta, 16 dic 1948 (fl), *Araque & Barkley 236* (MEDEL, MO, US).

Mandevilla bogotensis (Kunth) Woodson, Ann. Missouri Bot. Gard. 19:73. 1932. *Echites bogotensis* Kunth, Nov. Gen. Sp. (quarto ed.) 3:215, t. 243. 1819. *Amblyanthera bogotensis* (Kunth) Müll. Arg., Linnaea 30:452. 1860. *Anartia bogotensis* (Kunth) Miers, Apocyn. S. Amer. 82. 1878. TIPO: COLOMBIA. CUNDINAMARCA: cerca de Santa Fé de Bogotá, s.d. (fl), *A. Humboldt & A. Bonpland s.n.* (HOLOTIPO: P-HB [foto F neg. 38736]; ISOTIPO: US).

Dipladenia achrestogyne Woodson, Ann. Missouri Bot. Gard. 18:543–544. 1931. *Mandevilla achrestogyne* (Woodson) Woodson, Ann. Missouri Bot. Gard. 20:677. 1933, syn. nov. TIPO: COLOMBIA. CUNDINAMARCA: cañón rocoso, Chapinero, cerca de Bogotá, 2800–2900 m, 18–23 sep 1917 (fl), *F. Pennell 2034* (HOLOTIPO: NY [fotografía, INB]).

Mandevilla subpaniculata Woodson, Ann. Missouri Bot. Gard. 19:71. 1932, syn. nov. *Echites macrophyllus* Zahlbr., Ann. K.K. Naturhist. Hofmus. 7(1–2):5. 1892, nom. illeg., non Kunth (1818[1819]). TIPO: ECUADOR. PICHINCHA: Tambillo, 9 jul 1878 (fl), *Jelski 32* (HOLOTIPO: W; ISOTIPO: K [fotografía, INB]).

Distribución y hábitat.—NO de Venezuela, Colombia y Ecuador, en bosques montanos y premontanos, entre 1350–3000 m.

Mandevilla bogotensis se puede confundir con *M. pubescens*, pero se separa por sus brácteas florales, sépalos y corolas más pequeñas. Adicionalmente, es algo similar a *M. paisae*, pero esta última especie tiene sépalos mucho más anchos medialmente.

Dipladenia achrrestogyne y *M. subpaniculata* son reducidas a la sinonimia, pues sus colecciones tipo no difieren del tipo de *E. bogotensis*.

Especimenes representativos examinados: **Cundinarmarca:** Cordillera Oriental, entre San Miguel y La Aguadita, 21 Abr 1946 (fl, fr), *García-Barriga 12103* (COL, INB, US). **Putumayo:** entre Sachamates y San Francisco de Sibundoy, quebrada Susunga, 30 Dic 1940 (fl), *Cuatrecasas 11443* (COL, F, US). **Valle:** Cordillera Occidental, Las Brisas, monte El Tabor, 19 Oct 1946 (fl), *Cuatrecasas 22415* (COL, F, MO, US, VALLE).

Mandevilla boliviensis (Hook. f.) Woodson, Ann. Missouri Bot. Gard. 20:716. 1933. *Dipladenia boliviensis* Hook. f., Bot. Mag. 95:t. 5783. 1869. TIPO: BOLIVIA: datos perdidos (fl), *R. Pearce 708* (HOLOTIPO: K [fotografía, MO]).

Mandevilla bella (Pittier) Woodson, Ann. Missouri Bot. Gard. 20:717. 1933. *Dipladenia bella* Pittier, J. Wash. Acad. Sci. 21:141. 1931. Tipo: VENEZUELA. Distrito Federal: Hacienda Puerto La Cruz, 2300 m. 28 ago–4 sep1918 (fl), *H. Pittier 8108* (holotipo: US).

Mandevilla cereola Woodson, Ann. Missouri Bot. Gard. 20:712. 1933. Tipo: BOLIVIA. La Paz: región de Mapiri, San Carlos, 29 ene 1929 (fl), *O. Buchtien 1737* (holotipo: US; isotipo: HBG)

Mandevilla pittieri Woodson, Ann. Missouri Bot. Gard. 23:378. 1936. Tipo: COSTA RICA. Cartago: bosques de Tuís, nov 1897 (fl), *H. Pittier 11551* (lectotipo, designado por Morales, Brittonia 50:220. 1998: US; isolectotipo: US [fotografía, INB]).

Distribución y hábitat.—Costa Rica, Colombia a Venezuela y Bolivia, en bosques húmedos a muy húmedos y bosques nubosos entre 200–2000 m.

Esta especie se puede reconocer por sus hojas con los coléteres aglomerados en la base del nervio central, hojas glabras y con la base cuneada a obtusa y corolas blancas. Otras especies con flores blancas en Colombia se pueden separar por las hojas con los coléteres distribuidos a lo largo del nervio central.

Especímenes representativos examinados: **Guajira:** Serranía de Macuira, 26 jul 1977 (fl), *Bernal & Sugden 91* (COL, MO).

Mandevilla bracteata (Kunth) Kuntze, Revis. Gen. Pl. 2:414. 1891. *Echites bracteatus* Kunth, Nov. Gen. Sp. (cuarto ed.) 3:217. 1818 [1819]. *Exothostemon bracteatum* (Kunth) G. Don, Gent. Hist. 4:82. 1838. Tipo: COLOMBIA. Cundinamarca: cerca de Mariquita, jun 1801 (fl, fr), *A. Humboldt & A. Bonpland s.n.* (holotipo: P-HB [foto F neg. 38735]).

Mandevilla attenuata Rusby, Descr. S. Amer. Pl. 89–90. 1920. Tipo: COLOMBIA. Antioquia: entre Las Partidas y Valparaíso, 2 jun 1899 (fl), *H. Smith 1663* (holotipo: NY; isotipos: CM, F [foto, INB], G, GH, K, MICH, MO, P [2 pliegos], US, W, WIS).

Distribución y hábitat.—Endémica a Colombia, en bosques muy húmedos, entre 1200–2200 m.

En general, esta especie es confundida con *M. mollissima*, otro taxón morfológicamente muy similar y endémica a Colombia, pero *M. bracteata* se puede separar con facilidad por sus brácteas florales foliáceas.

Especímenes representativos examinados: **Cauca:** entre Timba y Suarez, río Cauca, 25 abr 1992 (fl), *Ramos & Reyna 3636* (CUVC, MO). **Cundinamarca:** Bogota, río Hacha, 1844 (fl), *Linden 1614* (P). **Huila:** Embalse de Betania, 9 jun 1987 (fl, fr), *Rojas et al. 111* (COL). **Magdalena:** San Sebastián de Rábago, 6 mar 1948 (fl, fr), *Romero-Castañeda 875* (COL, F, MO, US). **Nariño:** entre Aponte y Tablón, río Aponte, 18 dic 1944 (fl), *Ewan 16650* (BM, MO [2 pliegos], US). **Valle:** Cerro de las Curces, cerca de Cali, 21 may 1944 (fl), *Killip & Cuatrecasas 38398* (COL, F, MO, US, VALLE).

Mandevilla callista Woodson, Ann. Missouri Bot. Gard. 20:700. 1933. Tipo: COLOMBIA. Boyacá: El Humbo, al N de Bogota, 25 mar 1933 (fl), *A. Lawrence 710* (holotipo: F [2 pliegos, fotos F neg. 59199, 59200]; isotipos: G [fotografía, INB], GH, K, S [fotografía, INB]).

Distribución y hábitat.—Colombia, Ecuador, Perú y Bolivia, en bosques húmedos o nubosos entre 400–1800 m.

Una de las especies que más fácilmente se puede reconocer en Colombia, por el gran tamaño de sus hojas glabras, ovadas y conspicuamente cordadas basalmente, con los coléteres distribuidos a lo largo del nervio central, así como por sus corolas con el tubo blanco a crema-blanco y los lóbulos blancos basalmente y rosados-rosado-morados a morados distalmente.

Especímenes representativos examinados: **Antioquia:** Frontino, corregimiento Nutibara, río Cuevas, 14 jul 1987 (fl), *Sánchez et al. 1414* (HUA, MEDEL). **Boyacá:** NO de Bogota, 8 jun 1932 (fl), *Lawrence 182* (F, G, GH [2 pliegos], MO, NY, US). **Cundinamarca:** Albán, vereda Java, Granjas del Padre Luna, 18 may 2002 (fl), *Betancur et al. 9609* (COL). **Putumayo:** La Tortuga, 25 abr 1935 (fl), *García-Barriga 4626* (COL, US).

Mandevilla caquetana J.F. Morales, J. Bot. Res. Inst. Texas 3:567, f. 2. 2009. Tipo: COLOMBIA. Caquetá: Solano, sabanas del Yari, Chorro de la Gamitana, 7–14 abr 1997 (fl), *A. Arbeláez et al. 832* (holotipo: INB; isotipos: COAH, HUA).

Distribución y hábitat.—Endémica a Colombia, en vegetación asociada a afloramientos rocosos entre 350–750 m.

Esta especie puede confundirse con *Mandevilla nacarema*, ya que ambas comparten hojas con las venas terciarias no evidentes, así como inflorescencias con brácteas florales escariosas y corolas amarillas, pero *M. caquetana* se separa por sus hojas con el ápice obtuso-mucronado, redondeado-mucronado a emarginado-mucronado (vs. agudas), flores pediceladas (vs. sésiles) y hábito escandente (vs. erecto). El nombre *Mandevilla obtusifolia* Monach. (endémica a Venezuela) ha sido incorrectamente aplicado para esta especie.

Especímenes representativos examinados: **Caqueta:** sierra de Chiribiquete, cueva de las Pinturas, 21 Ago 1992 (fr), *Palacios et al. 2404* (COAH, COL, P).

Mandevilla caurensis Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:87. 1924. Tipo: VENEZUELA. Bolívar: Caura, cerca de Santa Lucía, 7 dic 1901 (fl), *Passarge & Selwyn 86* (holotipo: B [destruido, foto F neg. 4522]). Amazonas: Atures, carretera Puerto Ayacucho-Samariapo, al S de La Tortuga, 17 ene 1993 (fl, fr), *A. Gröger & J. Mutke 715* (neotipo, designado aquí: M; isoneotipos: BONN, MO, VEN).

Distribución y hábitat.—E de Colombia y el SO de Venezuela, creciendo en vegetación asociada a formaciones graníticas, en elevaciones de 0–300 m.

Mandevilla caurensis es un taxón restringido a afloramientos graníticos en la cuenca baja amazónica, donde llega a perder las hojas totalmente durante el inicio de la floración. Esta especie se distingue por sus hábito erecto a suberecto, hojas glabras o cerca de eso, con las venas secundarias dispuestas ca. en ángulo recto respecto al nervio central y corolas blancas.

Un neotipo es designado, dado que el holotipo fue destruido en la Segunda Guerra Mundial y no se localizaron duplicados adicionales en otros herbarios.

Especimenes representativos examinados: **Guainá:** al S de Casualito, río Orinoco, 22 jun 1984 (fl), *Davidse & Miller 26397* (VEN). **Vichada:** parque nacional El Tuparro, cerca del laboratorio, 25 feb 1985 (fl, fr), *Zarucchi & Barbosa 3387* (COAH, INB, MO).

Mandevilla cercophylla Woodson, Ann. Missouri Bot. Gard. 19:61. 1932. Tipo: PERÚ. Huanuco: Casapi, 1835 (fl, fr), *A. Mathews 1978* (holotipo: CGE; isotipos: E, K).

Distribución y hábitat.—SO de Colombia, Ecuador y Perú, en bosques muy húmedos y bosques nubosos, entre 1600–2500 m.

Mandevilla cercophylla se puede reconocer por la siguiente combinación de caracteres: hojas con la base aguda, con los coléteres aglomerados en la base del nervio central, la lámina glabra y con la venación secundaria apenas impresa abaxialmente, usualmente inconspicua adaxialmente y corolas hipocrateriformes, con los estambres insertos en la parte distal, justo antes de la boca.

Especimenes representativos examinados:**Valle del Cauca:** Santa Helena, Topacio, parque nacional Cali, 10 dic 1985 (fl), *Gentry et al. 53040* (CUVC, INB, MO, WAG).

Mandevilla colombiana J.F. Morales, Sida 21:1538, f. 2. 2005. Tipo: COLOMBIA. Amazonas: Puerto Santander, trocha a La Chorrera, al SO de Araracuara, 24 nov 1993 (fl), *D. Cárdenas et al. 4206* (holotipo: INB; isotipos: COAH, COL).

Distribución y hábitat.—Endémica, en vegetación asociada a afloramientos rocosos entre 50–350 m.

Mandevilla colombiana es una de las especies más fáciles de reconocer en Colombia, por sus hojas linear-elípticas y su habitat restringido a zonas bajas de la cuenca amazónica. En esa región, se puede confundir con *M. annularifolia*, otro taxón de hojas lineares, pero que se separa por sus hojas verticiladas (vs. opuestas en *M. colombiana*).

Especimenes representativos examinados: **Amazonas:** río Caquetá, Araracuara, nov 1982 (fl), *Idrobo et al. 11265* (COL). **Caquetá:** Solano, Paujil, río Caquetá, NO de Araracuara, 3 dic 1993 (fl, fr), *Arbeláez & Sueroque 505* (COAH, COL, HUA, INB, U).

Mandevilla cuneifolia Woodson, Bot. Mus. Leafl. 18:169. 1958. Tipo: COLOMBIA. Vaupés: río Piraparaná, Caño Teemeeña, 6 sep 1952 (fl), *R. Schultes & I. Cabrera 17234* (holotipo: MO; isotipos: COL, US).

Distribución y hábitat.—NE de Colombia (Vaupés) y el N de Brasil, en vegetación asociada a afloramientos graníticos, en elevaciones bajo los 300 m.

Esta especie es muy similar a *M. scabra*, pero se puede separar por sus hojas con la base anchamente aguda a obtusa (vs. cordada a subcordada), glabras (vs. generalmente pubescentes abaxialmente), así como por sus inflorescencias reducidas y con pocas flores. En Colombia, este taxón se conoce únicamente del tipo y fuera de este país, solo se conocen 2 colecciones de los estados de Amazonas y Roraima en Brasil.

Mandevilla gracilis (Kunth) J.F. Morales, Sida 21:1540, f. 3. 2005. *Echites gracilis* Kunth, Nov. Gen. Sp. (quarto ed.) 3:219. 1818 [1819]. *Exothostemon gracile* (Kunth) G. Don, Gent. Syst. 4:82. 1838. Tipo: VENEZUELA. Amazonas: inter Cataractas Ature et Maypure, río Orinoco, may (fl, fr), *A. Humboldt s.n.* (holotipo: P-HB [fotografías, INB]).

Mandevilla linearis N. E. Br., Trans. Linn. Soc. London. Bot. 6:48. 1901. Tipo: GUYANA: Valle Kotinga, 1894 (fl), *McConnel & Quelch 194* (lectotipo, designado por Morales, Sida 21:1541. 2005: K [fotografía, INB]).

Distribución y hábitat.—Colombia, Venezuela, Guyana y Brasil, en sabanas y vegetación asociada a afloramientos rocosos, entre 750–1400 m.

Mandevilla gracilis se puede reconocer con facilidad por sus hojas con la lámina linear-elíptica a linear, con las venas terciarias evidentes, inflorescencias con brácteas florales escariosas y corolas infundibuliformes amarillas. El nombre *M. leptophylla* (A. DC.) K. Schum. (endémica a Brasil) ha sido incorrectamente aplicado para esta especie: para mayores detalles véase el trabajo de Morales (2005b).

Especímenes representativos examinados: **Caquetá:** río Caquetá, al O de caño Paujil, 3 dic 1988 (st), *Sánchez et al. 1914* (COAH)

Mandevilla hirsuta (Rich.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. *Echites hirsutus* Rich., Actes Soc. Hist. Nat. Paris 1:107. 1792. *Echites richardii* Roem. & Schult., Syst. Veg. 4:391. 1819, nom. illeg. *Amblyanthera hirsuta* (Rich) Miers, Apocyn. S. Amer. 185. 1878. Tipo: GUYANA FRANCESA: Cayenne, 1792 (fl), *Leblond s.n.* (LECTOTIPO, designado por Allorge, Phytologia 84:305. 1998: P-LA [fotografía, INB]; ISOLECTOTIPOS: C, G-DC [foto F neg. 26863], P [2 pliegos]).

Distribución y hábitat.—México a Brasil, Paraguay y Bolivia, en bosques húmedos a muy húmedos entre 0–2000 m.

La especie más común del género se puede reconocer por sus hojas con la base auriculada y cordada, con indumento variable, coléteres dispuestos a lo largo del nervio central, inflorescencias con brácteas florales y sépalos foliáceos o subfoliáceos, así como corolas infundibuliformes y flores pediceladas. El color de la corola es típicamente amarillo con la garganta roja, aunque si bien formas totalmente crema o incluso blanco-crema pueden ser encontradas.Un listado completo de la sinonimia actual de esta especie puede ser consultada en Morales (2007a).

Especímenes representativos examinados: **Amazonas:** O de Leticia, 2 jul 1967 (fr), *Plowman & Martin 136* (GH). **Antioquia:** carretera San Carlos-San Rafael, 25 oct 1987 (fl), *Brant & Roldán 1499* (COL, HUA, MA, MO, USF). **Boyacá:** Santa María, vereda Caño Negro, camino de Santa María a Cuchilla Negra, 2 nov 2003 (fl, fr), *Granados-Tochoy et al. 400* (COL, INB). **Caldas:** Norcasia, Proyecto Hidroeléctrico La Miel, jul 1999 (fl, fr), *Vargas 6176* (HUA). **Caquetá:** Florencia, vereda Villarás, entre Florencia y Suaza, 26 nov 1993 (fl), *Ramírez et al. 5667* (JAUM, MO). **Casanare:** Llanos de San Martín, 30 sep 1916 (fl), *Dawe 287* (K). **Chocó:** río San Juan, cerca de Andagoya, 14 abr 1979 (fl), *Forero et al. 5265* (COL, INB, MO). **Córdoba:** Ayapel, entre La Escobilla y Hacienda Canime, 3 abr 1990 (fl), *Marulanda 2036* (HUA). **Guajira:** Sierra Nevada de Marta, entre Takina-Magatama-San Miguel y Pueblo Viejo, 17 ago 1986 (fl), *Cuadros & Gentry 2795* (MO). **Guaviare:** San José del Guaviare, inspección de la Fuga, Filo del Hambre, 21 mar 1996 (fl), *López et al. 1233* (COAH, COL). **Meta:** Los Llanos, SE de Orocué, 15 abr 1939 (fl), *Haught 2768* (COL, MO, US). **Nariño:** Cabo Manglares, 6 jul 1952 (fl), *Romero-Castañeda 3152* (COL). **Putumayo:** río Putumayo, río Mocoa, 7 ago 1964 (fl), *Soejarto 1230* (COL). **Santander:** quebrada La Sorda, 12 ago 1977 (fl), *Rentería et al. 527* (COL). **Valle:** Lojita, 1944 (fl), *Cuatrecasas 16434* (COL, F, MO, US, VALLE). **Vaupés:** San José del Guaviare, 11 nov 1939 (fl), *Cuatrecasas 7657* (COL). **Vichada:** Las Gaviotas, 11 jun 1976 (fl, fr), *Zarucchi 1685* (COAH).

Mandevilla jasminiflora Woodson, Ann. Missouri Bot. Gard. 28:273. 1941. Tipo: COLOMBIA. Quindío: sin localidad exacta, feb 1937 (fl), *E. Dryander 2145* (HOLOTIPO: US [fragmento, MO]).

Quiotania colombiana Zarucchi, Novon 1:33, fig. 1. 1991, syn. nov. Tipo: COLOMBIA. Antioquia: La Unión, carretera Sonsón a La Unión, 8 dic 1986 (fl), *J. Zarucchi & N. Bedoya 4510* (HOLOTIPO: HUA; ISOTIPOS: COL n.v., K n.v., MO, US).

Distribución y hábitat.—Endémica a Colombia, en bosques nubosos, entre 1850–2900 m.

De todas las especies de *Mandevilla* reportadas para Colombia, *M. jasminiflora* se puede reconocer con facilidad por el tamaño de sus flores, las cuales no exceden los 4 mm de largo. En términos generales, esta especie se puede confundir con una *Forsteronia* (por el tamaño de las flores), pero este último género tiene inflorescencias cimosas.

Quiotania colombiana fue tratado incorrectamente como un sinónimo de *M. ligustriflora* Woodson por Simões, et al. (2007), otra especie diferente endémica a Ecuador. Ambos taxones pueden separarse fácilmente por la forma de la corola, ya que *M. jasminiflora* tiene corolas hipocrateriformes, mientras que *M. ligustriflora* tiene corolas infundibuliformes.

Especímenes representativos examinados: **Antioquia:** Medellín, corregimiento Alta Vista, cabeceras Quebrada la Picacha, 23 abr 1997 (fl, fr), *Rodríguez et al. 590* (HUA, INB, JAUM). **Santander:** Betulia, vereda San Bernardo, 6 feb 2000 (st), *Velásquez & Trujillo 1275* (JAUM).

Mandevilla javitensis (Kunth) K. Schum., Nat Pflanzenfam. 4(2):171. 1895. *Echites javitensis* Kunth, Nov. Gen. Sp. (quarto ed.) 3:220. 1818 [1819]. *Exothostemon javitense* (Kunth) G. Don, Gen. Hist. 4:82. 1838. Tipo: VENEZUELA. Amazonas: río

Temi, cerca de Javita (Misiones del Orinoco), jun año perdido (fl), *A. Humboldt & A. Bonpland 970* (LECTOTIPO, designado por Morales, An. Jard. Bot. Madrid 64:156. 2007: P-HB [foto F neg. 38737]).

Amblyanthera spruceana Müll. Arg., Fl. Bras. 6:143. 1860. *Mandevilla spruceana* (Müll. Arg.) K. Schum., Nat. Pflanzenfam. 4 (2):171. 1895. TIPO: BRASIL. AMAZONAS: cerca de Panure y río Uaupes, oct 1852–ene 1853 (fl), *R. Spruce 2863* (LECTOTIPO, designado por Morales, An. Jard. Bot. Madrid 64:156. 2007: CGE; ISOLECTOTIPOS: K [2 pliegos], P, W [fotografía, INB]).

Mandevilla stephanotidifolia Woodson, Bot. Mus. Leafl. 18:176. 1958. TIPO: COLOMBIA. VAUPÉS: río Apaporis, Cachivera de Jirijirimo y alrededores, 16 sep 1951 (fl), *R. Schultes & I. Cabrera 14010* (HOLOTIPO: MO; ISOTIPOS: COL, US).

Distribución y hábitat.—SE de Colombia, S de Venezuela y N de Brasil, en vegetación asociada a afloramientos rocosos y formaciones de arena blanca, entre 50–400 m.

Mandevilla javitensis es un taxón restringido a la amazonía que se reconoce por sus hojas con los coleteres distribuidos a lo largo del nervio central, la lámina con la base obtusa e inflorescencias con brácteas florales foliáceas y flores cortamente pediceladas, con pedicelos hasta 2 mm de largo. Otros taxones que habían sido segregados basados en la forma de las brácteas florales, fueron reducidos a la sinonimia por Morales (2007b).

Especimenes representativos examinados: **Amazonas:** La Pedrera, río Caquetá, cerro Yupati, 9 mar 1990 (fl), *Galeano et al. 2019* (COL, HUA, NY). **Guainía:** Maimachi, Serranía del Naquén, 12 abr 1993 (fl), *Barbosa & Madriñán 8428* (GH, INB, MO). **Vaupés:** Mitú, río Pararná-Pichuna, 2 jul 1975 (fr), *Zarucchi 1375* (COL, GH, K).

Mandevilla lancibracteata Woodson, Fieldiana, Bot. 28:500. 1953. TIPO: VENEZUELA. TÁCHIRA: entre Las Delicias y Paraguita, río Táchira, 12 jul 1944 (fl), *J. Steyermark 57144* (HOLOTIPO: MO; ISOTIPOS: F [foto F neg. 51180], VEN).

Mandevilla lata Markgr., Acta Biol. Venez. 6(1–4):71. 1971 [1972], syn. nov. TIPO: VENEZUELA. FALCÓN: Sierra de San Luis, S de La Tabla, 16 jul 1967 (fl), *J. Steyermark 98942* (HOLOTIPO: Z [fotografía, INB]; ISOTIPO: VEN [fotografía, INB]).

Distribución y hábitat.—Colombia y Venezuela, en bosques húmedos o nubosos, entre 1300–1700 m.

Mandevilla lancibracteata se puede confundir con *M. moritziana*, pero se separa por sus corolas con la parte inferior del tubo de 7–9 mm de largo (vs. 14–20 mm) y hojas no bulladas (vs. generalmente bulladas).

Especimenes representativos examinados: **Norte de Santander:** entre Toledo y Santa Inés, 30 mar 1987 (fl), *Lozano et al. 5447* (COL, INB). **Santander:** Tona, sitio El Mortiño, carretera Bucaramanca-Cúcuta, 20 jun 2004 (fl), *Betancur et al. 10757* (COL).

Mandevilla lancifolia Woodson, Ann. Missouri Bot. Gard. 19:74. 1932. TIPO: VENEZUELA. AMAZONAS: Puerto Ayacucho, may 1931 (fl), *E. Holt & E. Blake 819* (HOLOTIPO: MO; ISOTIPOS: NY, US).

Mandevilla lancifolia Woodson var. *calva* Monac., Mem. New York Bot. Gard. 10:133. 1958. TIPO: VENEZUELA. AMAZONAS: Región de San Fernando de Atabapo, Caño Cupueni, río Orinoco, 12 nov 1953 (fl), *B. Maguire et al. 36208* (HOLOTIPO: NY; ISOTIPOS: F [foto F neg. 51181], K, US).

Mandevilla angustissima Markgr., Acta Bot. Venezuel. 13:354–355. 1978. TIPO: VENEZUELA. AMAZONAS: cerca del aeropuerto de Puerto Ayacucho, 6 may 1973 (fl), *G. Morillo 3151* (HOLOTIPO: Z; ISOTIPO: VEN).

Distribución y hábitat.—SE de Colombia y S de Venezuela, en sabanas arenosas o rocosas y bosques de galería, en elevaciones de 50–400 m.

Mandevilla lancifolia se caracteriza por presentar hojas lineares, linear-elípticas a angostamente elípticas, opuestas y con los coléteres distribuidos a lo largo del nervio central, así como inflorescencias con brácteas escariosas y corolas con lóbulos blancos. Se puede confundir con *M. gracilis*, pero este último taxón tiene corolas con lóbulos amarillos.

Especimenes representativos examinados: **Caquetá:** Solano, río Mesay, Chorro Jacameya, 25 nov 1995 (fl), *Cárdenas et al. 6868* (COAH, MO). **Guainía:** río Inírida, Mavecurí, 6 mar 1965 (fl), *Fernandez & Jaramillo 7093* (COL). **Guaviare:** Mesa La Lindosa, 19 sep 1985 (fl), *Idrobo 11837* (COL). **Meta:** Puerto López, El Naranjal, sep 1997 (fl), *Quiceno s.n.* (COL). **Vichada:** El Tuparro, 29 ago 1979 (fl), *Vincelli 1211* (COAH, COL, MA).

Mandevilla longipes Woodson, Ann. Missouri Bot. Gard. 35:233–234. 1948. TIPO: COLOMBIA. BOYACA: La Chapón, 27 jul 1932 (fl, fr), *A. Lawrance 361* (HOLOTIPO: MO; ISOTIPOS: BM, F [fotocopia, INB]).

Distribución y hábitat.—Endémica al NO de Colombia, creciendo en bosques muy húmedos entre 800–1750 m.

Esta especie se confunde con facilidad con *M. subsagittata* y *M. xerophytica*: de la primera se separa fácilmente por sus corolas blancas (vs. amarillas o amarillas con la boca roja), mientras que de la segunda se puede separar por sus flores con pedicelos 10–24 mm de largo (vs. 3–7,5 mm de largo).

Especímenes representativos examinados: **Antioquia:** E de San Rafael, entre Guatapé-San Rafael, 26 oct 1987 (fl, fr), *Brant & Roldan 1534* (HUA, INB, MO, USF). **Boyacá:** Togüi, vereda Carare, 19 Ago 1978 (fl), *Know & Know 48* (COL). **Chocó:** río San Juan, carretera Andagoya-Condoto, cerca de Andagoya, 14 Abr 1979 (fl), *Forero et al. 5232* (COL, INB, MO).

Mandevilla megabracteata J.F. Morales, J. Bot. Res. Inst. Texas 1:866, f. 4. 2007. TIPO: GUYANA: Región Potaro-Siparuni, montañas Pakaraima, Mt. Wokomung, cabeceras de Wusupubaru creek, 17 feb 1993 (fl, fr), *T. Henkel et al. 1447* (HOLOTIPO: INB; ISOTIPOS: MO, P, US).

Distribución y hábitat.—Colombia y Guyana, en bosques muy húmedos, entre 800–1150 m.

Esta especie se puede confundir con *M. steyermarkii*, ya que ambas tienen inflorescencias con brácteas florales foliáceas y conspicuas, pero *M. megabracteata* se puede reconocer por sus tallos hirsutos y sépalos más largos (9–10 mm vs. 2,5–3 mm). Una discusión más extensa de la relación con otros taxones, puede ser consultada en Morales (2007a).

Especímenes representativos examinados: **Cesar:** La Jagua de Ibirico, vereda Alto de las Flores, 9 mar 1996 (fl), *Fernández-Alonso et al. 13186* (COL).

Mandevilla mollissima (Kunth) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. *Echites mollissimus* Kunth, Nov. Gen. Sp. 3:218. 1818 [1819]. *Exothostemun mollissimun* (Kunth) G. Don., Gent. Hist. 4:82. 1838. 82. TIPO: COLOMBIA. TOLIMA: entre Honda y mina Santana ("Crescit inter Honda et fodinam Santannae"), julio, año perdido (fl), *A. Humboldt & A. Bonpland s.n.* (HOLOTIPO: P-HB [foto F neg. 4536]; ISOTIPO: B [n.v., probablemente destruido]).

Distribución y hábitat.—Endémica, en bosques húmedos a muy húmedos, bosques nubosos, entre 900–2000 m.

Esta especie se confunde comúnmente con *M. bracteata*, otra especie endémica a Colombia, pero *M. mollissima* se puede separar con facilidad por sus inflorescencias con brácteas florales escariosas.

Especímenes representativos examinados: **Antioquia:** Barbosa, estación Popalito, al NE de Medellín, 9 ago 2003 (fl, fr), *Morales et al. 9444* (HUA, INB). **Caldas:** La Merced, vereda La Primera Quiebra, 3 ene 1991 (fl), *Arias 71* (HUA). **Cauca:** Cordillera Central, Inzá, parque arqueológico de San Andres, 15 abr 1953 (fl), *Idrobo & Weber 1346* (COL, MO, US). **Cundinamarca:** entre San Francisco y La Vega, 1 abr 1944 (fl, fr), *García-Barriga 10965* (COL, MO [fotografía, S], US). **Huila:** SE de Altamira, cerca de Guadalupe, 9 ene 1974 (fl), *Gentry et al. 9001* (COL, F, MO, Z). **Magdalena:** Curatacá, 9 mar 1948 (fl), *Romero-Castañeda 911* (COL, F, MO). **Nariño:** Ricaurto, carretera La Planada-San Isidro, 6 nov 1995 (fl), *González et al. 1289* (PSO, QCA). **Putumayo:** Sibundoy, 27 may 1935 (fr), *García-Barriga 4710* (COL, US). **Santander:** Mesa de Los Santos, 21 nov 2001 (fr), *Albesiano et al. 1123* (COL). **Tolima:** camino a Melgar, entre Icononzo y Boca de Monte, 18 abr 1946 (fl, fr), *García-Barriga 12027* (COL, US). **Valle del Cauca:** quebrada San Blas, vereda Galilea, 29 dic 1942 (fl), *Fosberg 19661* (US).

Mandevilla montana (Kunth) Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:82. 1924. *Echites montanus* Kunth, Nov. Gen. Sp. (quarto ed.) 3:213. 1818 [1819]. TIPO: COLOMBIA. Pasto: andes de Pasto, río Guaytara, dic año perdido (fl, fr), *A. Humboldt & A. Bonpland 2168* (HOLOTIPO: P-HB [foto F neg. 4527]; ISOTIPOS: F, P).

Mandevilla pogonocalyx Woodson, nom. nud.

Distribución y hábitat.—SO de Colombia y Ecuador, en bosques muy húmedos entre 1700–2800 m.

Uno de los taxones más pobremente recolectados en Colombia, *Mandevilla montana* se puede confundir con *M. cercophylla*, pero se separa por sus flores con los sépalos más grandes (3–5 vs. 1–1,4 mm), corola con el tubo rojizo (vs. verde a verde-amarillento) y hojas densamente puberulentas a tomentulosas abaxialmente (vs. glabras).

Especímenes representativos examinados: **Cauca:** Popayán, finca La Lomita, 13 ene 2001 (fl), *Díaz & Perdomo 1228* (COL, CAUP, INB). **Nariño:** Pasto, Cebadal, carretera a Yacuanquer, 2 jun 1946 (fl), *Schultes & Villareal 7933* (GH, MO, US).

Mandevilla moritziana (Müll. Arg.) Donn. Sm., Enum. Pl. Guatem. 3:50. 1893. *Amblyanthera moritziana* Müll. Arg., Linnaea 30:421. 1860. TIPO: VENEZUELA. Aragua: cerca de Vento Grande, s.d. (fl), *Moritz 31* (HOLOTIPO: G-BOIS [foto F neg. 4528]; ISOTIPO: BM).

Distribución y hábitat.—N de Colombia y Venezuela, en bosques muy húmedos y bosques nubosos, entre 1500–1900 m de elevación.

Esta especie se confunde con *M. lancibracteata*, pero *M. moritziana* se separa por sus hojas bulladas, sépalos más cortos, corolas con la parte inferior del tubo más larga y botones florales con el ápice agudo o cortamente apiculado.

Especimenes representativos examinados: **Santander:** La Corcova, Tona, 12 oct 1977 (fl), *Merchán 665* (COL, MO); La Corcova, Tona, 12 oct 1977 (fl, fr), *Renteria et al. 665* (COL, HUA [2 pliegos]).

Mandevilla nacarema J.F. Morales, sp. nov. (**Fig. 1**). TIPO: COLOMBIA. META: Sierra de la Macarena, escarpamiento del Norte, 6 feb 1950 (fl, fr), *W. Philipson 2379* (HOLOTIPO: COL [fotografías, INB]; ISOTIPO: BM).

A *Mandevilla caquetana* J.F. Morales, cui affinis, foliis apice obtusis-mucronatis vel rotundatis-mucronatis (vs. acutis) et floras sessilis (vs. pedicellatis) differt.

Subarbusto, aparentemente erecto; ramitas irregular y levemente aplanadas y papilado puberulentas cuando jóvenes, cilíndricas a subcilíndricas y glabrescentes o glabras con la edad, usualmente sólidas; coléteres interpeciolares inconspicuos, hasta 0,4 mm de largo. Hojas usualmente opuestas; pecíolos hasta 0,9 mm de largo; láminas foliares 1,5–3,5 cm × 5,5–9,5 mm, angostamente ovado-elípticas a angostamente ovadas, el ápice agudo, la base cordada a subcordada, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, glabras en ambas superficies, excepto por el indumento esparcido e inconspicuo distribuido a lo largo del nervio central, sobretodo en la mitad proximal, no bulladas, sin domacios, el márgen no revoluto, las venas secundarias apenas impresas en ambas superficies, la venación terciaria no evidente. Inflorescencias ligeramente más largas que las hojas subyacentes, axilar, inconspicua y esparcidamente puberulenta, con hasta 9 (o más) flores, pedúnculo 2–3 mm de largo, pedicelos ausentes (flores sésiles), brácteas 1,7–2,8 × 0,7–1,1 mm, linear-ovadas, escariosas; sépalos 1,9–2,2 × 0,7–0,9 mm, angostamente ovados, similares, el ápice acuminado, no reflexo, escariosos, glabros externamente, con un coléter solitario,entero a subentero apicalmente; corola infundibuliforme, amarilla, glabra externamente, el tubo algo giboso basalmente, la parte inferior 14–15 × 1,8–2,8 mm, la parte superior 14–15 mm de largo, angostamente campanulada, con un diámetro de 7,5–8,5 mm en la boca, el ápice del botón floral cortamente acuminado; lóbulos 14–16 × 110–11 mm, obovados, aparentemente algo reflexos distal y marginalmente; estambres insertos en la base de la parte superior del tubo, anteras 3–3,2 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas truncadas, cabeza estigmática 1,2–1,4 mm de largo; ovario 1,4–1,6 mm de largo, glabro; nectario anular e irregularmente pentalobulado, ca. la mitad de la longitud del ovario o un poco más corto. Folículos 5,4–6,2 cm × 1–2,8 mm, no fusionados longitudinalmente, solo unidos en su región apical, glabros, levemente articulados (moniliformes); semillas ca. 5 mm, glabras o glabrescentes, coma 0,6–1,3 cm de largo, amarillenta a canela-amarillenta.

Distribución y hábitat.—Endémica a la Sierra de la Macarena, Departamento de Meta, creciendo en vegetación asociada a afloramientos graníticos en elevaciones de 900 m.

Mandevilla nacarema se puede reconocer por su hábito arbustivo, hojas cortamente pecioladas, casi sésiles, con la lámina foliar angostamente ovado-elíptica a angostamente ovada, inflorescencias con brácteas escariosas y flores sésiles. Especies de *Mandevilla* erectas son algo típicamente relacionado con afloramientos rocosos (granito o cuarzita por mencionar algunos) y formaciones asociadas, presentes desde la amazonia colombiana y Venezuela hasta el Sureste y Sur de Brasil. En Colombia la presencia de este tipo de especies erectas es algo muy inusual, siendo *M. nacarema* el primer taxón con esta característica reportada en el país.

El epíteto de esta especie es un anagrama de la localidad tipo, una región con un alto endemismo y casi totalmente inexplorada.

Mandevilla nerioides Woodson, Ann. Missouri Bot. Gard. 28:274. 1941. TIPO: COLOMBIA. GUAVIARE: San José del Guaviare, 12 nov 1939 (fl), *J. Cuatrecasas 7674* (HOLOTIPO: US; ISOTIPOS: COL, F, foto F neg. 51182, P, US).

Mandevilla thevetioides Markgr., Mem. New York Bot. Gard. 18:290. 1969. TIPO: COLOMBIA. AMAZONAS: río Caquetá, 9 jun 1959, *B. Maguire et al. 44170* (LECTOTIPO, designado por Morales, An. Jard. Bot. Madrid 64:156. 2007: US; ISOLECTOTIPOS: COL, VEN, Z).

Mandevilla manarana Morillo, An. Jard. Bot. Madrid 48:28, t. 1. 1990. TIPO: COLOMBIA. VAUPÉS: río Kuyudari, cerro Yapoboda, 5 oct 1951 (fl), *R. Schultes & I. Cabrera 14207* (HOLOTIPO: GH; ISOTIPOS: COL [2 pliegos], MO, US).

Distribución y hábitat.—Colombia y el S de Venezuela, en vegetación asociada a rocas graníticas, formaciones de arena blanca y sabanas, en elevaciones de 50–700 m.

Mandevilla nerioides se encuentra cercanamente relacionada con *M. lancifolia* y *M. thevetioides* Woodson, pero se puede separar por sus flores más grandes y anchas. Más comentarios sobre las relaciones de estas especies pueden encontrarse en Morales (2007a).

FIG. 1. *Mandevilla nacarema* (*W. Philipson 2379*, COL). **A.** Ramita con flores y frutos. **B.** Detalle de la superficie adaxial de la hoja, mostrando los coléteres a lo largo del nervio central. **C.** Porción de la inflorescencia mostrando la flor sésil, y el tubo de la corola parcialmente abierto, mostrando la posición de las anteras y el tubo giboso en la base. **D.** Vista adaxial de dos sépalos y coléteres. **E.** Antera, vista dorsal. **F.** Cabeza estigmática. **G.** Nectario y ovario. **H.** Semilla.

Especimenes representativos examinados: **Amazonas:** río Caquetá, cerca de Araracuara, 10 nov 1982 (fl), *Idrobo et al. 11250* (COAH, COL, HUA, INB, NY). **Caquetá:** Solano, río Caquetá, Paujíl, NO de Araracuara, 3 dic 1993 (fr), *Arbeláez & Sueroque 559* (COAH, HUA, U). **Guainía:** Puerto Huesito, entre Caño Caquita y Caño Gente, ago 1975 (fl), *García-Barriga 20910* (COL, US). **Guaviare:** San José del Guaviare, Puerto Arturo, 25 ago 1995 (fl), *Cárdenas et al. 6549* (COAH, INB, MO). **Vaupés:** Caño Cubiyú, comunidad indígena La Sabana, 26 abr 1993 (fl), *Madriñan et al. 1136* (COL, INB, MO, NY, VEN).

Mandevilla nevadana J.F. Morales, Anales Jard. Bot. Madrid 63:51, f. 1. 2006. TIPO: COLOMBIA. MAGDALENA: Sierra Nevada de Santa Marta, quebrada Indiana, 1 sep 1972 (fl), *J. Kirkbride 2051* (HOLOTIPO: INB; ISOTIPOS: COL, US).

Distribución y hábitat.—Endémica, en márgenes de bosques entre 1300–1650 m.

Mandevilla nevadava se puede confundir con *M. subsagittata*, pero se separa por el tubo de la corola más cortos (13–15 mm vs. 20–35 mm) y botones florales con el ápice anchamente agudo a obtuso (vs. corta y abruptamente acuminado o apiculado).

Especimenes representativos examinados: **Magdalena:** Asan Javier, 21 ene 1959 (fl), *Romero-Castañeda 7006* (COL, NY).

Mandevilla paisae J.F. Morales, Candollea 60:52, f. 2–3. 2005. TIPO: COLOMBIA. ANTIOQUIA: carretera a Urrao, páramo de Frontino, 19 may 1985 (fl), *D. Cárdenas 127* (HOLOTIPO: HUA [2 pliegos, fotografías, INB]).

Distribución y hábitat.—Endémica, en bosques nubosos, entre 2400–3650 m.

Mandevilla paisae se encuentra relacionada con *M. bogotensis* y *M. pubescens*, pero se reconoce por los sépalos más anchos y brácteas florales rápidamente deciduas. Para una mayor discusión, véase el trabajo de Morales (2005a).

Mandevilla pavonii (A. DC.) Woodson, Ann. Missouri Bot. Gard. 19:73. 1932.

Echites hirsutus Ruiz & Pav., Fl. Peruv. 2:19, t. 136. 1799, nom. illeg., non Rich. (1792). *Prestonia hirsuta* (Ruiz & Pav.) Spreng., Syst. Veg. 1:637. 1825. *Echites pavonii* A. DC., Prodr. 8:463. 1844. *Amblyanthera pavonii* (A. DC.) Müll. Arg., Linnaea 30:450. 1860. TIPO: PERÚ. Datos de localidad perdidos, 1778–1788 (fl), *H. Ruiz & H. Pavon 11/57* (HOLOTIPO: MA; ISOTIPOS: B [destruido, foto F neg. 4529], G-DC).

Distribución y hábitat.—S de Colombia, Ecuador, Perú, Brasil y Bolivia, creciendo en bosques de galería, sabanas y bosques secos en elevaciones de 100–1300 m.

Mandevilla pavonii es muy similar a *M. sagittarii*, ya que ambas tienen hojas con la superficie abaxial tomentulosa y con la base generalmente cordada o subcordada, secando de un color blanco a blanco grisáceo, pero el primer taxón se separa con facilidad por sus corolas hipocrateriformes (vs. infundibuliformes).

Especimenes representativos examinados: **Amazonas:** Leticia, comunidad Nazaret, río Amazonas, 5 abr 2000 (fl), *Arias 724* (COAH, COL, HUA).

Mandevilla pubescens (Willd. ex Roem. & Schult.) J.F. Morales, comb. nov. *Echites pubescens* Willd. ex Roem. & Schult., Syst. Veg. 4:796. 1819. *Echites congestus* Kunth, Nov. Gen. Sp. (quarto ed.) 3:214. 1818 [1819], nom. illeg. *Prestoniopsis pubescens* (Willd. ex Roem. & Schult.) Müll. Arg., Bot. Zeitung (Berlin). 18:22. 1860. *Dipladenia congesta* K. Schum., Nat. Pflanzenfam. 4(2):169. 1895, nom. illeg. *Mandevilla congesta* (K. Schum.) Woodson, Ann. Missouri Bot. Gard. 20:675. 1933. TIPO: COLOMBIA. CAUCA: Popayán?, s.d. (fl), *A. Humboldt & A. Bonpland s.n.* (HOLOTIPO: P-HB [2 pliegos, foto F neg. 38733]; ISOTIPO: F).

Dipladenia fendleri Müll. Arg., Linnaea 30:417. 1860. *Prestoniopsis fendleri* (Müll. Arg.) Miers, Apocyn. S. Amer. 168. 1878. TIPO: VENEZUELA. MÉRIDA: cerca de Colonia Tovar, 1854–1855 (fl), *A. Fendler 1030* (HOLOTIPO: K; ISOTIPOS: GH, G-DC [foto F neg. 26845], NY [fotocopia, INB], MO).

Dipladenia stenoloba Müll. Arg., Observ. Bot. 158. 1871. TIPO: ECUADOR. TUNGURAHUA: Tungurahua, may 1878 (fl), *R. Spruce 5390* (HOLOTIPO: K [2 pliegos]; ISOTIPOS: B [destruido], C, CGE, G-DC [foto F neg. 26847], P, W.

Prestoniopsis hirsuta Miers, Apocyn. S. Amer. 167. 1878. TIPO: VENEZUELA. MÉRIDA: cerca de Colonia Tovar, s.d. (fl), *J. Moritz s.n.* (HOLOTIPO: BM [fotografía, INB).

Prestoniopsis venosa Miers, Apocyn. S. Amer. 167. 1878. TIPO: VENEZUELA. MÉRIDA: cerca de Colonia Tovar, s.d. (fl), *J. Moritz s.n.* (HOLOTIPO: BM [fotografía, INB).

Distribución. NO de Venezuela, Colombia y Ecuador, en bosques nubosos entre 1800–2800 m.

Mandevilla pubescens es muy similar a *M. bogotensis* y *M. paisae*, grupo de taxones que comparten en común hojas con los coléteres aglomerados en la base del nervio central y corolas con los estambres insertos cerca de la base (véase descripción en esas especies). La publicación de "Nova Genera et Species Plantarum"

volumen III (Humboldt et al. 1818) ocurrió en el mismo año que "Systema Vegetabilium" volumen IV (Roemer & Schultes 1819), ya que a pesar de la obra de Humboldt tiene como año de publicación "1818," en realidad fue publicado en durante el verano de 1819. Sin embargo, el volumen IV de Systema Vegetabilium fue "publicado casi con certeza durante inicios de la primavera de 1819" (McVaugh, Taxon 4:83. 1955). Por lo tanto, *Echites congestus* Kunth es un nombre ilegítimo, pues es un homónimo que cita como colección tipo, el mismo espécimen citado para *E. pubescens* Roem. & Schult., taxón que tiene prioridad por ser publicado en forma anterior. Por lo tanto, se propone una nueva combinación basado en *E. pubescens*.

Especímenes representativos examinados: **César:** Sierra Nevada de Santa Marta, río Donachui, entre Sogrome y Sacarecungüe, 9 may 1974 (fl), *Plowman & Davis 3655* (COL). **Caldas:** Manizales vereda la Esperanza, reserva Torre Cuatro, 31 mar 1999 (fl), *Alvear et al. 385* (COL). **Cundinamarca:** cerca de Guasca, 27 may 1947 (fl, fr), *Haught 5769* (COL, F, K, MO, US). **Magdalena:** Sierra Nevada de Santa Marta, río Donachuí, 13 oct 1959 (fr), *Cuatrecasas & Romero-Castañeda 24841* (COL, MO, US). **Quindió:** Cordillera Central, Cocora, E de Salento, 13 feb 1986 (fl), *Stein 3442* (COL, JAUM, MO, USF, WAG). **Risaralda:** La Pastora, reserva Ucumari, 13 oct 1989 (st), *Rangel et al. 5637* (COL, MO).

Mandevilla puyumato J.F. Morales, sp. nov. (**Fig. 2**). Tipo: COLOMBIA. Putumayo: municipio Mocoa, corregimiento de San Antonio, vereda Alto Campucana, finca La Mariposa, vertiente amazónica de Colombia, 20 abr–1 may 1994 (fl, fr), *J.L. Fernández-Alonso, A. Camero, Z. Marín & E. Mesa 11273* (holotipo: COL [fotografías, INB]).

A *Mandevilla polyantha* K. Schum. ex Woodson cui affinis, pedicellis 6–9 mm longis (vs. 11–33 mm), calycis laciniis1,9–2,1 mm longis (vs. 1,3–1,7 mm) et corollae sparse hirsutulis (vs. glabris) differt.

Liana; ramitas subcilíndricas y papilado puberulentas cuando jóvenes, cilíndricas a subcilíndricas y con el indumento perdido y reducido a las papilas con la edad, usualmente sólidas; coléteres interpeciolares inconspicuos, hasta 0,5 mm de largo. Hojas usualmente opuestas; pecíolos 5–15 mm de largo; láminas foliares 5,5–8,2 × 3–4,5 cm, elípticas, el ápice acuminado a caudado-acuminado, la base cordada a subcordada, raramente obtusa, los coléteres irregularmente distribuidos a lo largo del nervio central, membranáceas, la superficie adaxial glabra, excepto por el indumento esparcido e distribuido a lo largo del nervio central, la superficie abaxial similar, pero con tricomas muy esparcidos en la lámina y nervaduras, no bulladas, sin domacios, el márgen no revoluto, las venas secundarias impresas en ambas superficies, la venación terciaria reticulada y evidente, pero más ligeramente impresa en el haz. Inflorescencia conspicuamente más larga que las hojas subyacentes, axilar, densa a moderadamente hirsutulo-puberulenta, con muchas flores, pedúnculo 1,1–2,1 cm de largo, pedicelos 6–9 mm de largo, brácteas 4–5,5 × 0,4–0,6 mm, lineares, escariosas; sépalos 1,9–2,1 × 0,9–1,2 mm, angostamente ovados, similares, el ápice acuminado, no reflexos, escariosos, muy esparcidamente hirsutulos a glabrescentes externamente, con un coléter solitario, entero a subentero apicalmente; corola infundibuliforme (solo botones examinados), blanco-amarillentas, esparcidamente hirsutula externamente, el tubo algo giboso basalmente, la parte inferior 11–12,5 × 1,1–1,5 mm, la parte superior 8–9 mm de largo, angostamente cónica, con un diámetro de ca. 5 mm en la boca, el ápice del botón floral agudo-apiculado; lóbulos no examinados; estambres insertos en la base de la parte superior del tubo, anteras 3–3,1 mm de largo, glabras dorsalmente, la base auriculada, con las aurículas subtruncadas, cabeza estigmática 1,2–1,3 mm de largo; ovario 1–1,2 mm de largo, glabro; nectario anular e irregularmente pentalobulado, ca. la mitad de la longitud del ovario. Folículos 19,2–24,8 cm × 1,1–4 mm, no fusionados longitudinalmente, solo unidos en su región apical, glabros, levemente articulados (moniliformes); semillas 8,5–10 mm, diminuta y esparcidamente puberulentas, coma 1,5–2,5 cm de largo, amarillenta.

Distribución y hábitat.—Endémica al departamento de Putumayo, en bosques húmedos entre 1350–1420 m.

En Colombia esta especie se puede confundir con *M. scabra*, pero *M. puyumato* tiene pedicelos más largos (6–9 vs. 1–4 mm), corolas con la parte superior del tubo más pequeña (8–9 vs. 13–20(–27) mm) semillas diminuta y esparcidamente puberulentas (vs. glabras).

El epíteto de esta especie es un anagrama del Departamento de Putumayo, una zona bastante inexplorada, debido al conflicto armado que se vive en Colombia.

Mandevilla riparia (Kunth) Woodson, Ann. Missouri Bot. Gard. 19:58. 1932. *Echites riparius* Kunth, Nov. Gen. Sp. 3:214. 1819. Tipo: COLOMBIA. Magdalena: Tenerife, río Magdalena, mayo, año perdido (fl), *A. Humboldt & A. Bonpland 3711* (holotipo: P-HB; isotipo: P [foto F neg. 38734]).

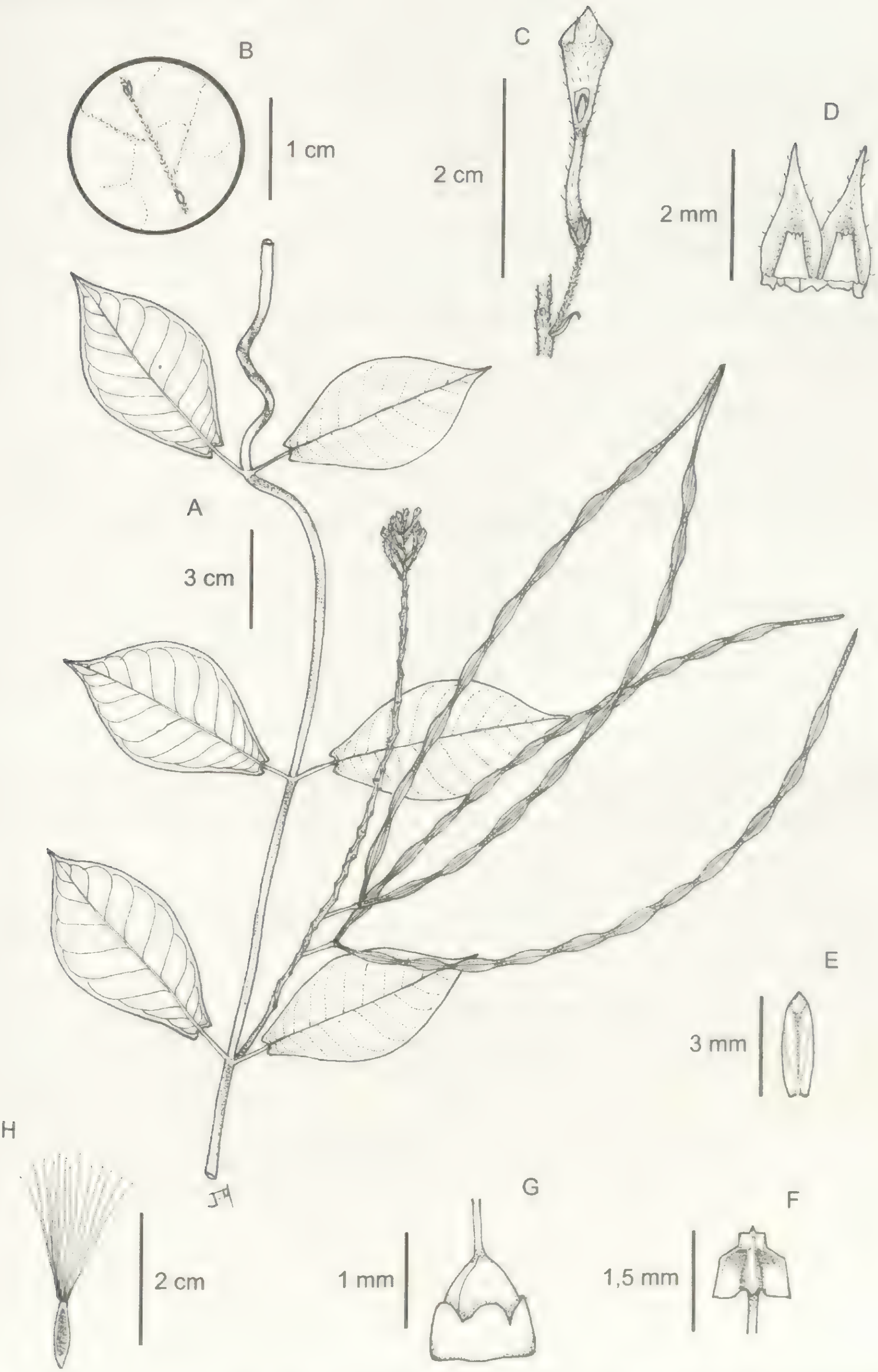

FIG. 2. *Mandevilla puyumato* (*J.L. Fernández et al. 11273*, COL). **A.** Ramita fértil con flores y frutos. **B.** Detalle de los coléteres a lo largo del nervio central adaxialmente. **C.** Botón floral parcialmente abierto, mostrando las brácteas, posición de las anteras y el tubo basalmente giboso. **D.** Vista adaxial de dos sépalos removidos, mostrando los coléteres. **E.** Antera, vista dorsal. **F.** Cabeza estigmática. **G.** Nectario y ovario. **H.** Semilla.

Mandevilla montana (Kunth) Markgr. var. *peruviana* Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:82. 1924. Tipo: PERÚ. Cajamarca: Chota, Tucupampa (Llama-Huambos), 17 mar 1997 (fl, fr), *A. Sagástegui et al. 15954* (neotipo, designado por Morales, Revista Acad Colomb. Ci. Exact. 29:47. 2005: INB; isoneotipos: F, HAO [destruido], USF).

Distribución y hábitat.—Colombia (?) y Perú, en vegetación arbustiva asociada a formaciones rocosas entre 2000–2900 m.

Mandevilla riparia se puede reconocer por sus hojas con los coléteres aglomerados en la base del nervio central e inflorescencias con corolas infundibuliformes, con el tubo de 10–14 mm de largo. La presencia de *Mandevilla riparia* en Colombia es dudosa, ya que hasta la fecha, excepto por el tipo de la especie, supuestamente colectado en Tenerife, en el valle del río Magdalena, no se ha vuelto a colectar en el país. Un dato importante es que Tenerife es un municipio con una elevación de ca. 20 m.s.n.m., mientras que en Perú, esta especie no se reporta bajo los 2000 m de elevación. Sin embargo, el tipo es idéntico al material peruano.

Mandevilla rugellosa (Rich.) L. Allorge, Phytologia 84:305. 1998 [1999]. (**Fig. 3**). *Echites rugellosus* Rich., Actes Soc. Hist. Nat. Paris 1:107. 1792. Tipo: Guyana Francesa: Cayenne, 1792 (fl, fr), *M. Leblond 366* (lectotipo, designado por Allorge-Boiteau, Phytologia 84:305. 1998: P-LA; isolectotipos: G [foto F neg. 26866], G-DC).

Echites subspicatus Vahl, Eclog. Amer. 2:18. 1798. *Laseguea subspicata* (Vahl) Miers, Apocyn. S. Amer. 252. 1878. *Mandevilla subspicata* (Vahl) Markgr., Recueil Trav. Bot. Neerl. 22:380. 1926. Tipo: SURINAME: datos perdidos (fl), *C. von Rohr s.n.* (holotipo: C [foto F neg. 22267, dibujos, C, F]; isotipo: B [destruido]).

Echites rubricaulis Poir., Encycl., Suppl. 2:535. 1812. Tipo: GUYANA: datos perdidos (fl), *L. Richard s.n.* (holotipo: P; isotipos: CGE, P-JU).

Echites brachystachyus Benth., J. Bot. (Hooker) 3:248. 1841. *Mitozus brachystachyus* (Bentham) Miers, Apocyn. S. Amer. 222. 1878. Tipo: GUYANA: localidad perdida, Abr 1839 (fl), *R. Schomburgk 565* (holotipo: G [foto F neg. 26860]; isotipo: P).

Echites antennaceus A. DC., Prodr. 8:456. 1844. *Amblyanthera antennacea* (A. DC.) Müll. Arg., Linnaea 30:448. 1860. *Laseguea antennacea* (A. DC.) Miers, Apocyn. S. Amer. 251. 1878. *Mandevilla antennacea* (A. DC.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895, syn. nov. Tipo: PERU: datos perdidos, 1778–1788 (fl, fr), *H. Ruiz & H. Pavón s.n.* (holotipo: G-DC [foto F neg. 34139]; isotipo: MA).

Echites guianensis A. DC., Prodr. 8:458. 1844. *Amblyanthera guianensis* (A. DC.) Müll. Arg., Linnaea 30:448. 1860. *Mesechites guianensis* (A. DC.) Miers, Apocyn. S. Amer. 235. 1878. Tipo: GUYANA FRANCESA: Cayenne, datos perdidos (fl), *Perrottet s.n.* (holotipo: G-DC [foto F neg. 7561]).

Laseguea latiuscula Miers, Apocyn. S. Amer. 251–252., t. XXXV A. 1878. Tipo: GUYANA FRANCESA: Cayenne, s.d. (fl), *C. van Rohr s.n.* (holotipo: BM; isotipo: C).

Laseguea venustula Miers, Apocyn. S. Amer. 252. 1878. Tipo: GUYANA FRANCESA: Cayenne, s.d. (fl), *C. van Rohr s.n.* (holotipo: BM; isotipo: C).

Echites bolivianus Britton ex Rusby, Mem. Torrey Bot. Club 4:219. 1895. *Mandevilla boliviana* (Britton ex Rusby) Rusby, Bull. Torrey Bot. Club 25:496. 1898. Tipo: BOLIVIA. La Paz: Yungas, 1890 (fl), *M. Bang 551* (holotipo: NY; isotipos: F [fotografía, INB], M, MO, US).

Echites altescandens H. Winkl., Repert. Spec. Nov. Regni Veg. 7:243. 1909. Tipo: BOLIVIA. La Paz: Charopampa, cercanías de Mapiri, nov 1907 (fl), *O. Buchtien 1968* (holotipo: US).

Mandevilla tenuicarpa Rusby, Bull. New York Bot. Gard. 8:114. 1912. Tipo: BOLIVIA. Iturralde: Tumupasa, 14 jun 1902 (fr), *R. Williams 875* (lectotipo, designado aquí: NY; isolectotipos: BM, K).

Echites bracteosus Rusby, Mem. New York Bot. Gard. 7:325. 1927. *Mandevilla bracteosa* (Rusby) Woodson, Ann. Missouri Bot. Gard. 20:742. 1932, syn. nov. Tipo: BOLIVIA. La Paz: Ixiamas, 16 dic 1921 (fl, fr), *P. White 1142* (holotipo: NY [fotografía, INB]; isotipos: K, US).

Distribución y hábitat.—Colombia a Brasil y Bolivia, en bosques húmedos a muy húmedos entre 200–350 m.

Mandevilla rugellosa se ha confundido en forma general con *M. scabra*, dado que ambos taxones tienen hojas e inflorescencias morfológicamente muy similares. Sin embargo, ambas especies se pueden separar fácilmente basado en la forma de la corola, ya que mientras en *M. rugellosa* son claramente hipocrateriformes, en *M. scabra*, son típicamente infundibuliformes.

Por primera vez se propone la sinonimización de *Mandevilla antennacea* en el concepto de *M. rugellosa*. Dado que ambas especies fueron altamente contrastadas en la clave de la monografía de Woodson (1933) y por presentar un carácter morfológico que usualmente es de extrema utilidad en el género, como lo es la contextura de las brácteas florales (foliáceas vs. escariosa), se hace necesaria una discusión completa de las razones para proponer esta sinonimia.

En forma general, no solo en *Mandevilla* sino también en otros géneros de la tribus Mesechiteae y Echiteae, la contextura de las brácteas florales es un carácter bastante útil, para separar, no solo especies, sino

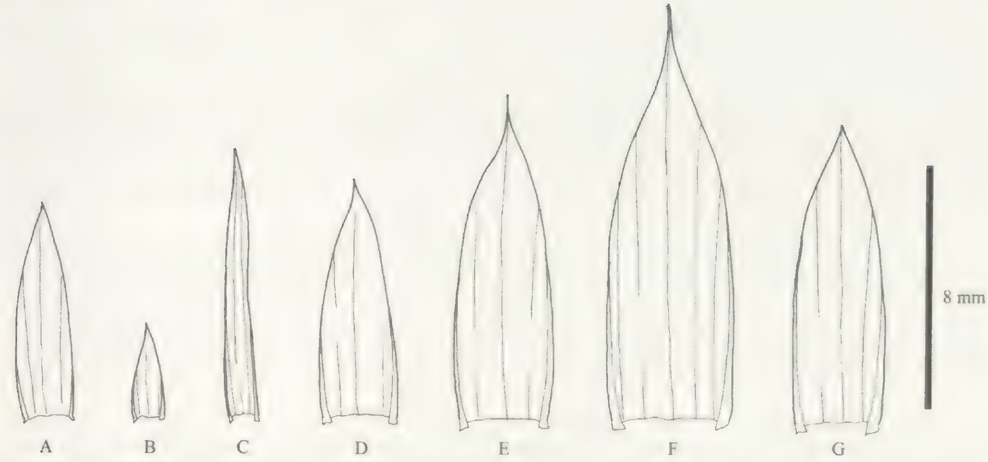

Fig. 3. **Variación de las brácteas de *Mandevilla rugellosa*. A.** *Maguire & Stahel 24994* **(MO). B.** *Colella et al. 1446* **(NY). C.** *Jansen-Jacobs et al. 2518* **(U). D.** *Cremers et al. 9690* **(P). E.** *Gentry et al. 52310* **(INB). F.** *Rimachi 3029* **(F). G.** *Schunke 972* **(COL).**

también en algunos casos géneros. De esta manera, *Asketanthera* puede ser fácilmente separado al instante de los géneros relacionados (e.g., *Fernaldia*, *Echites*) por sus brácteas florales conspicuamente foliáceas (vs. escariosas en los citados géneros). De la misma manera, este carácter es determinante para separar varios grupos de taxas altamente relacionados en *Mandevilla*.

Woodson (1933) separó *M. antennacea* y *M. subspicata* (= *M. rugellosa*) del resto de especies del subgénero *Exothostemon* por la forma de la corola, ya que pocas especies tienen corolas hipocrateriformes en ese subgénero, siendo más predominantes las corolas infundibuliformes. A su vez, ambos taxas y otra especie adicional reconocida por Woodson (*M. bracteosa*) fueron separados por la forma de las brácteas, ya que *M. subspicata* fue caracterizada por la presencia de brácteas escariosas, 4–6 mm de largo, mientras que las otras dos especies se separaron por sus brácteas foliáceas, 7.5–12.5 mm de longitud. Ahora bien, el resto de caracteres utilizados comprendían distribuciones geográficas disyuntas, así como pubescencia y textura de las hojas distintas. El estudio de todas las colecciones tipos de las especies descritas y sinonimizadas bajo estos nombres, ha demostrado que todas son similares, y que comparten en común prácticamente todos los caracteres morfológicos. El estudio de solo las colecciones tipos, sin especímenes adicionales puede llevar a la errónea conclusión de las tres especies son diferentes, púes las diferencias en la forma de las brácteas, pueden ser considerados caracteres discontinuos. Sin embargo, el estudio de dicho carácter en conjunción con los numerosos duplicados disponibles hoy en día, ha demostrado que la forma y largo de las brácteas varía en forma continua a través del rango de distribución, sin mostrar ninguna discontinuidad que haga posible la separación. Aunque si bien, al examinar los rangos extremos en la forma de las brácteas (escariosas vs. foliáceas) en especímenes en forma aislada, podría sugerir que se trata de especies diferentes, existen numerosas colecciones las cuales presentan caracteres intermedios que hacen prácticamente imposible su separación (Fig. 3). De esta forma, por ejemplo, el largo de las brácteas varía desde 3–3,5 × 1 mm (*Miller & Hauk 9413*, INB), 5–7 × 1,5–2 mm (*Lohmann & Peckham 146*, INB), 6–8 × 1,5–2 mm (*Granville 6932*, INB), 7–12 × 2–3,5 mm (*Jardim 570*, INB), hasta los rangos más largos o extremos tales como 9–14 × 3,5–4,5 (*Jardim 2324*, INB), 10–26 × 4–5 mm (*Zarucchi et al. 2685*, NY) o incluso hasta llegar formas muy largas y estrechas, tales como las presentes en la colección de Guillén & Chore 3671, donde las brácteas miden 9–14 × 1–2 mm. Por lo tanto, no es posible mantener el reconocimiento de estas especies basados en los caracteres propuestos, pues la intergradación presente no lo permite. Por otro lado, este carácter, así como el tipo y densidad del indumento de las hojas (usado también por Woodson para separarlas) es altamente variable en el subgénero *Exothostemon*, siendo el mejor ejemplo de ellos, *M. hirsuta*,

donde una altísima intergradación en la forma de las brácteas y tipo de indumento presente, que se presenta incluso en una misma zona geográfica, impide la segregación en diferentes entidades o incluso subespecies o variedades. Al ser examinadas en forma local o para regiones geográficas determinadas, la variación podría sugerir la separación de diferentes entidades, pero al ser analizadas en todo el rango de distribución en el marco de un estudio monográfico, la intergradación presente no lo permite. Asimismo, es importante recordar que la pubescencia por si sola, puede ser un carácter altamente variable en varios genéros de las Apocynaceae (Apocynoideae, Rauvolfioideae), siendo probablemente *Aspidosperma* y *Mandevilla*, los grupos con la más alta diversidad intraespecífica en ese carácter en las Apocynaceae neotropicales.

Mandevilla tenuicarpa es lectotipificada y *Williams 875* seleccionado como el lectotipo, por ser el sintipo con más duplicados disponibles y en mejor estado de preservación.

Especimenes representativos examinados: **Amazonas:** río Igara-Ipara, La Chorrera, fecha perdida (fl), *Sastre 3262* (COL, P).

Mandevilla sagittarii Woodson, Ann. Missouri Bot. Gard. 19:72. 1932. Tipo: COLOMBIA. Chocó: entre La Oveja y Quidbó, 1–2 abr 1931 (fl, fr), *W. Archer 1714* (holotipo: US; isotipo: COL).

Mandevilla dodsonii A. Gentry, Ann. Missouri Bot. Gard. 68:117. 1981, syn. nov. Tipo: ECUADOR. Los Ríos-Pichincha: fila en El Centinela, Montañas de Ila, camino de Patricia Pilar a 24 de Mayo, 6 feb 1979 (fl), *C. Dodson et al. 7523* (holotipo: MO; isotipo: SEL).

Distribución y hábitat.—Panamá, Colombia y Ecuador, en bosques muy húmedos, en elevaciones de 0–650 m.

En la descripción de *M. dodsonii* Gentry (1981), relaciona esta especie con *M. hirsuta* y enumera algunos caracteres para diferenciarlas. El estudio del espécimen tipo del primer taxón reveló que en realidad no difiere del tipo de *M. sagittarii* y que por lo tanto, debe ser reducida a la sinonimia. En Colombia, esta especie se puede confundir con *M. pavonii* (véase discusión en esa especie).

Especimenes representativos examinados: **Cauca:** Guapi, parque nacional Isla Gorgona, 10 sep 1987 (fl), *Estrada et al. 223* (COL), *Estrada et al. 224* (MA, MBM). **Chocó:** Pizarro, carretera Pepé-Puerto Meluk, 16 nov 1985 (fl), *Espina 1800* (CHOCO, COL, INB, MO). **Valle:** Bajo Calima, camino a Juanchaco Palmeras, 12 jul 1984 (fl, fr), *Gentry et al. 47985* (COL, CUVC, JAUM, MO, SI).

Mandevilla sancta-martae J.F. Morales, J. Bot. Res. Inst. Texas 3:569, f. 3. 2009. Tipo: COLOMBIA. Magdalena: Sierra Nevada de Santa Marta, E de quebrada Indiana, 1 sep 1972 (fl), *J. Kirkbride 2049* (holotipo: INB; isotipos: COL, NY, US, Z [fotografías, INB]).

Distribución y hábitat.—Endémica, bosques muy húmedos entre 1600–1700 m.

Esta especie se puede confundir con *M. mollissima* y *M. scabra*, pero se separa por sus hojas con domacios en la superficie abaxial, así como corolas con la parte inferior del tubo 9–10 mm de largo.

Especimenes representativos examinados: **Magdalena:** Sierra Nevada de Santa Marta, quebrada Botella, camino a San Pedro de la Sierra, 29 sep 1972 (fl), *Kirkbride 2277* (COL, US, Z).

Mandevilla scabra (Hoffmanns. ex Roem. & Schult.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. *Echites scaber* Hoffmann. ex Roem. & Schult., Syst. Veg. 4:795. 1819. Tipo: BRASIL: datos perdidos (fl), *Hoffmannsegg s.n.* (holotipo: B-W 5165 [foto F neg. 4496]).

Distribución y hábitat.—Colombia a Brasil y Bolivia, en bosques muy húmedos entre 150–750 m.

Una de las especies mas ampliamente distribuidas en Sur América se confunde con facilidad con *M. hirsuta*, pero *M. scabra* se separa por sus sépalos más pequeños (1,5–3,5 mm vs. 7–12 mm de largo) y brácteas florales escariosas de 2–6 mm de largo (vs. foliáceas y de 11–21 mm de largo). Otro taxón similar es *M. gracilis*, pero este ultimo tiene laminas foliares lineares o linear-elípticas.

Especimenes representativos examinados: **Amazonas:** ríos Igara-Paraná, 7 sep 1973 (fl, fr), *Sastre 2126* (COL, P). **Arauca:** Tame, caño Gualabao, 11 sep 1998 (fl), *Celis et al. 186* (COAH), *Celis et al. 214* (COAH). **Guaviare:** San José del Guaviare, serranía La Lindosa, 22 ago 1995 (fl), *Cárdenas et al. 6497* (COAH). **Guainía:** Caño Colorado, La Esperanza, 15 abr 1993 (fl), *Madriñan & Barbosa 1024* (COL, F, GH, INB, MEXU, MO, NY). **Meta:** Caracarate, 4 may 1945 (fl), *Giovanni 95* (COL, VEN). **Vaupés:** río Negro, San Felipe, 13–25 nov 1952 (fl, fr), *Humbert 27397* (MO, P, VEN). **Vichada:** Puerto Carreño, 7 abr 1995 (fl), *Córdoba et al. 1356* (COL).

Mandevilla schlimii (Müll. Arg.) Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. *Amblyanthera schlimii* Müll. Arg.

Linnaea 30:419. 1860. TIPO: COLOMBIA. NORTE DE SANTANDER: Ocaña, may 1846–1852 (fl), *J. Linden 575* (HOLOTIPO: G-BOIS; ISOTIPOS: BR, K [fotografía, INB], P [2 pliegos]).

Mandevilla alvarezii H. Daniel, Aspectos de una Flora (Colombia) 14. 1939, syn. nov. TIPO: COLOMBIA. ANTIOQUIA: Cocorná, dic 1937 (fl), *H. Daniel 2033* (HOLOTIPO: COL; ISOTIPOS: COL, F [foto F neg. 56480], MO, US).

Distribución y hábitat.—Colombia y Venezuela, en elevaciones de 900–2000 m.

Mandevilla schlimii se puede reconocer por sus corolas muy angostas, con un diámetro de 8–10 mm en la boca, así como hojas con la base obtusa a cuneada y láminas diminuta a densamente glauco-tomentulosas abaxialmente.

La colección tipo de *Mandevilla alvarezii* es virtualmente idéntica a la de *M. schlimii*, sin ninguna diferencia o discontinuidad morfológica evidente, por lo que el primer taxón es reducido a la sinonimia del segundo.

Mandevilla speciosa (Kunth) J.F. Morales, Novon 15:452. 2005. *Echites speciosus* Kunth, Nov. Gen. Sp. (quarto ed.) 3:219. 1818 [1819]. *Exothostemon speciosum* (Kunth) G. Don, Gent. Hist. 4:82. 1838. TIPO: VENEZUELA: datos perdidos (fl, fr), *A. Humboldt s.n.* (HOLOTIPO: P-HB [fotografías, INB]).

Amblyanthera fendleri Müll. Arg., Linnaea 30:417. 1860. *Mandevilla fendleri* (Müll. Arg.) Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. TIPO: VENEZUELA. MÉRIDA: cerca de Colonia Tovar, 1857 (fl), *A. Fendler 1032* (HOLOTIPO: G-DC [foto F neg. 26875]; ISOTIPOS: BR, F, K [en parte], MO, NY).

Distribución y hábitat.—Colombia, Venezuela, Guyana y el N de Brasil, en bosques húmedos y bosques nubosos, entre 1100–2250 m de elevación.

Mandevilla speciosa se puede confundir con *M. mollissima*, ya que ambas comparten hojas con la superficie abaxial pubescente, así como inflorescencias con brácteas escariosas, corolas infundibuliformes y folículos conspicuamente moniliformes, pero la primera se reconoce con facilidad por sus hojas ovadas a ovado-elípticas, con el ápice obtuso-mucronulado (vs. elípticas y con el ápice acuminado). *Mandevilla scabra* es algo similar, pero este taxón tiene los folículos más o menos continuos (vs. conspicuamente moniliformes en *M. speciosa*). Más detalles sobre la historia taxonómica y nomenclatural de esta especie puede ser consultada en Morales (2005c).

Especimenes representativos examinados: **Antioquia:** Urrao, Morro Pesetas, 11 ago 1995 (fl), *Cardona et al. 31* (HUA, INB). **Boyacá:** Alto Chapón, NO de Bogotá, 3 jun 1932 (fl), *Lawrence 143* (F, MO, S, US). **Cauca:** parque nacional Munchique, El Tambo, vereda La Romelia, 24 jul 1993 (fl, fr), *Velayos et al. 7010* (COL, MA). **Cundinamarca:** Laguna Pedro Palo, carretera Mosquera-La Mesa, 1 ago 1976 (fl), *Gentry & Fallen 17131* (COL, MO, Z). **Huila:** La Argentina, 25 sep 1984 (fl, fr), *Lozano et al. 4124* (COL, WIS). **Magdalena:** Sierra de Perijá, al E de Manaure, hacienda Nuevo Horizonte, 15 nov 1959 (fl), *Cuatrecasas & Romero-Castañeda 25371* (COL, US). **Nariño:** Ricaurte, Reserva Natural La Planada, 22 feb 1993 (fl), *Agudelo et al. 2954* (COL). **Quindio:** Pijao, vereda Carniceros, 24 ago 1993 (fl), *Vélez et al. 3361* (COL, HUQ). **Santander:** entre Pie de Cuesta y Las Vegas, 19–24 dic 1926 (fl), *Killip & Smith 16161* (US). **Tolima:** Santa Isabel, finca la Cima, 6 ago 1980 (fl), *Idrobo et al. 10661* (COL). **Valle:** carretera entre Cali-Loboguerrero y Bitaco, 24 jul 1997 (fl), *Croat & Gaskin 80320* (CUVC, INB, MO).

Mandevilla steyermarkii Woodson, Fieldiana, Bot. 28:502. 1953. TIPO: VENEZUELA. AMAZONAS: cercanías de Sanariapo, cerca de Río Sanariapo, 8 sep 1944 (fl), *J. Steyermark 58504* (HOLOTIPO: MO; ISOTIPOS: F [foto F neg. 50811], NY, VEN).

Distribución y hábitat.—Colombia, Venezuela y NO de Brasil, formaciones rocosas y sabanas, entre 50–300 m.

Mandevilla steyermarkii es un taxón fácil de reconocer por sus inflorescencias con brácteas florales foliáceas y conspicuas (una de las más grandes en el género), hojas cordadas y con los coléteres distribuidos a lo largo del nervio central y habitat restringido a las zonas bajas de la amazonía. Aunque puede ser confundido con *M. hirsuta*, este último taxón tiene brácteas más pequeñas y sépalos más grandes. Otra especie similar es *M. megabracteata* (véase discusión en esa especie).

Especimenes representativos examinados: **Guainía:** caño Tomo, río Negro, 26 oct 1977 (fl), *Espina et al. 267* (COL). **Vaupés:** río Vaupes, Cerro de Mitú, 7 sep 1951 (fl), *Schultes & Cabrera 13915* (COAH, COL, GH, MO, US). **Vichada:** El Tuparro, 9 nov 1971 (fl), *Daniel 131* (COL).

Mandevilla subcarnosa (Benth.) Woodson, Bull. Torrey Bot. Club. 58:453. 1931. *Echites subcarnosus* Benth., J. Bot. (Hooker) 3:247. 1841. *Mesechites subcarnosus* (Benth.) Miers, Apocyn. S. Amer. 232. 1878. TIPO: GUYANA: Cerca de Roraima, fecha perdida (fl), *R. Schomburgk 183* (LECTOTIPO, designado por Woodson, Ann. Missouri Bot. Gard. 20:773. 1936: K; ISOLECTOTIPO: BM).

Mandevilla glabra N. E. Brown, Trans. Linn. Soc. London, Bot. 6:47. 1906. Tipo: GUYANA: Monte Roraima, 1894 (fl), *J. Messrs et al. 16* (lectotipo, designado por Morales, An. Jard. Bot. Madrid 64:157: K [fotografía, INB]).

Mandevilla ulei Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:86, f. 2 M. 1924. Tipo: BRASIL. Amazonas: Manaos, 31 jul 1900 (fl), *E. Ule 5176* (lectotipo, designado por An. Jard. Bot. Madrid 64:157. 2007: HBG; isolectotipo: B [destruido, foto F neg. 4532]).

Mandevilla dielsiana Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:86, f. 2. 1924. Tipo: VENEZUELA. Bolivar: cerro Guaiquinima, 11 feb 1990 (fl), *B. Boom 9493* (neotipo, designado por Morales, An. Jard. Bot. Madrid 64:158. 2007: INB, isoneotipos: MO, NY, USF, VEN).

Distribución y hábitat.—S y SE de Venezuela, Guyana y el N de Brasil, en vegetación asociada a Tepuís y sabanas, en elevaciones de (150–)400–1800 m.

Mandevilla subcarnosa se puede confundir con la polimórfica *M. nerioides*, pero se separa por sus tallos jóvenes levemente angulados o acostillados (vs. conspicuamente alados), lóbulos de la corola amarillos (vs. rosados, blanco-rosados, a rosado-rojizos), y flores con pedicelos más largos.

Especimenes representativos examinados: **Caquetá:** base de los cerros cerca del campamento base, parque nacional natural Chiribiquete, 29 nov 1992 (fl, fr), *Barbosa et al. 8101* (MA)

Mandevilla subsagittata (Ruiz & Pav.) Woodson, Ann. Missouri Bot. Gard. 19:69. 1932. *Echites subsagittatus* Ruiz & Pav., Fl. Peruv. Prodr. 2:19. 1799. Tipo: PERÚ. Huanuco: Cuchero, datos perdidos, *H. Ruiz & H. Pavón 11/56* (holotipo: MA [3 pliegos, foto F neg. 29216]; isotipo: F).

Echites hirtellus Kunth, Nov. Gen. Sp. (quarto ed.) 3:213. 1819. *Mesechites hirtellus* (Kunth) Miers, Apocyn. S. Amer. 234. 1878. Tipo: COLOMBIA. Magdalena: cerca de Mariquita, jun 1801 (fl), *A. Humboldt & A. Bonpland 1757* (holotipo: P-HB [2 pliegos]; isotipo: F [fotocopia en INB]).

Echites guayaquilensis Miers, Apocyn. S. Amer. 233. 1878. *Mesechites guayaquilensis* (Miers) Miers, Apocyn. S. Amer. 233. 1878. Tipo: ECUADOR. Guayas: Guayaquil, 1837 (fl), *C. Hartweg 669* (holotipo: BM; isotipos: CGE, G-DC, K [2 pliegos]).

Distribución y hábitat.—México a Venezuela y Perú, Trinidad y las Antillas menores, en bosques secos y bosques húmedos o muy húmedos, entre 0–1600(–1800) m.

Mandevilla subsagittata es uno de los taxones más comunes en en Colombia y con una amplia variabilidad en la densidad del indumento y tamaño de las hojas. En Colombia esta especie se puede confundir con *M. villosa*, pero se separa por sus brácteas florales escariosas (vs. foliáceas). Otro taxón similar en *M. nevadana* (véase descripción en esa especie).

Especimenes representativos examinados: **Antioquia:** camino a Salgar, cerca de carretera Bolombolo-Bolivar, 29 sep 1987 (fl), *Zarucchi et al. 5918* (HUA, INB, MO, USF). **Bolivar:** O de La Jagua, 27 Ago 1943 (fl), *Haught 3642* (COL, MO, US). **Caldas:** La Victoria, entre Cañaveral y Fierritos, finca El Placer, 23 Ago 1999 (st), *Vélez 2225* (JAUM). **César:** Valledupar, Puerto Bello, 13 Jul 1983 (fl), *Cuadros 1688* (COL, US). **Cundinamarca:** entre La Esperanza y San Javier, 15 Ene 1947 (fl), *Garcia-Barriga 12186* (COL, US). **Guajira:** San Antonio, 18 Ago 1986 (fl), *Cuadros & Gentry 2832* (MO, USF). **Guaviare:** San José del Guaviare, puero Arturo, río Guaviare, 25 Ago 1995 (fl), *Cárdenas et al. 6556* (COAH). **Huila:** Pitalito, vereda El Triunfo, 11 mar 2005 (fl), *Silva et al. 591* (COL, FMB). **Magdalena:** Santa Marta, 1898–1901 (fl), *Smith 1662* (BM, BR, CM, COL, F, K, MO, NY, P [2 pliegos], S, US). **Meta:** Los Llanos, río Meta, Cabuyaro, 14 oct 1938 (fl), *Cuatrecasas 3626* (COL, F, US). **Nariño:** Barbacoas, río Viza, Mar 1995 (fl), *Fernández et al. 12410* (COL). **Norte de Santander:** valle del río Peralonso, alrededor de Santiago, 21 Dic 1948 (fl), *Araque & Barkley 141* (MEDEL, MO, US). **Putumayo:** Mocoa, 27 Dic 1940 (fl, fr), *Cuatrecasas 11375* (COL, F, US). **Quindío:** La Tebaida, río La Vieja, 21 nov 1986 (fl), *Arbeláez et al. 1805* (HUA, HUQ). **Risaralda:** carretera La Virginia-Cerritos, río Cauca, 8 May 1989 (fl), *Silverstone-Sopkin et al. 5203* (MO). **Santander:** Cordillera Oriental, Sarare, río Cubuyon, El Indio, 13 nov 1941 (fl), *Cuatrecasas 13112* (COL, MO, US). **Tolima:** O de Chaparral, 29 Jul 1950 (fl, fr), *Smith 1299* (COL, F, MO, UC, US). **Valle:** Alto del Dinde, entre Cartago y Alcalá, 16 nov 1946 (fl), *Cuatrecasas 22906* (COL, F, MO, US, VALLE). **Vaupés:** río Kuduyari, Yapoboda, 15 Ago 1960 (fl, fr), *Schultes & Cabrera 22614a* (COL, GH, MO, NY).

Mandevilla symphitocarpa (G. Mey.) Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. *Echites symphitocarpus* G. Meyer, Prim. Fl. Esseq. 132. 1818. *Mitozus symphitocarpus* (G. Mey.) Miers, Apocyn. S. Amer. 222. 1878. Tipo: Essequibo, s.d. (fl?), *G. Meyer s.n.* (no localizado) Guyana. Región Demerara-Berbice, río Essequibo, al N de Barica, 18 may 1993 (fl, fr), *T. Henkel & R. Williams 2088* (neotipo, aquí designado: INB; isoneotipos: MO, U, US)

Echites cuyabensis A. DC., Prodr. 8:462. 1844. *Amblyanthera cuyabensis* (A. DC.) Müll. Arg., Linnaea 30:450. 1860. *Mitozus cuyabensis* (A. DC.) Miers, Apocyn. S. Amer. 223. 1878. *Mandevilla cuyabensis* (A. DC.) K. Schum., Nat. Pflanzenfam. 4(2):171. 1895. Tipo: BRASIL. Mato Grosso: Cuyaba, 1832 (fl), *Silva & Manso 2* (holotipo: G-DC; isotipo: B [destruido, foto F neg 4523]).

Distribución y hábitat.—Colombia a Brasil, Bolivia y Trinidad, en elevaciones de 0–500 m.

En forma general, esta especie es similar a la común *M. scabra*, pero tiene flores mucho más grandes (sé-

palos, tubo, lóbulos, anteras, etc). La colección tipo de *Echites symphitocarpus* G. Meyer (*Meyer s.n.*) no fue localizado en ningún herbario europeo (aún despúes de una extensa búsqueda) y ante la carencia de otros sintipos citados en la descripción original, se hace necesario la escogencia de un neoTIPO:

Especimenes representativos examinados: **Amazonas:** río Caquetá, Araracuara, 18 oct 1990 (fl), *Dulmen & Matapi 17* (COAH, INB, MO). **Guaviare:** san José del Guaviare, entre caserio Nare y Guanapalo, 22 mar 1996 (fl), *López et al. 1266* (COAH). **Vaupés:** río Kuduyari, 17 ago 1960 (fl), *Schultes 22698* (COL, MO).

Mandevilla thevetioides Woodson, Bot. Mus. Leafl. 18:177. 1958. TIPO: COLOMBIA. VAUPÉS: río Kananarí, cerro Isibukuri, 29 oct 1951 (fl), *R. Schultes & I. Cabrera 14508* (HOLOTIPO: MO; ISOTIPOS: COL, NY, US).

Distribución y hábitat.—SE de Colombia, en vegetación asociada a afloramientos rocosos en elevaciones bajo los 500 m.

Mandevilla thevetioides es un taxón pobremente recolectado, conocido hasta la fecha solo por 3 colecciones. Por sus hojas angostas (hasta ca. 1 cm de ancho) con las venas secundarias conspicuas y las venas terciarias no impresas, puede ser confundida con la variable *M. nerioides*, pero *M. thevetiodes* se puede separar con facilidad por sus hojas dispuestas en verticilos de 3.

Especimenes representativos examinados: **Vaupés:** Mitú, río Vaupés, comunidad de los cerros, ago 1993 (fl), *Martínez et al. 330* (COL, HUA).

Mandevilla trianae Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. TIPO: COLOMBIA. CHOCÓ: localidad perdida, abr 1853 (fl), *J. Triana 3409* (HOLOTIPO: BM; ISOTIPO: COL [fotografía, INB]).

Distribución y hábitat.—Colombia, Venezuela, Guyana, Ecuador y Perú, en bosques muy húmedos, entre 50–1200(–1800) m.

Una especie relativamente común en Colombia, *Mandevilla trianae* se puede confundir con *M. scabra* y *M. hirsuta*, pero se separa de estas especies por sus corolas con un diámetro de 5–10 mm en la boca.

Especimenes representativos examinados: **Amazonas:** Leticia, camino a Tarapacá, 20 jul 1965 (fl), *Lozano et al. 530* (COL). **Antioquia:** San Luis, cerca de Medellín, 15 sep 1988 (fl), *Betancur et al. 621* (F, HUA, MA, MO, SI). **Caquetá:** Araracuara, 4 may 1989 (fl, fr), *Wal 179* (COAH). **Cauca:** Santa Rosa, Bota Caucana, 4 jul 1998 (fl, fr), *González 1030* (COL, CAUP). **Chocó:** entre ríos San Pablo y Pato, 22 abr 1979 (fl), *Forero et al. 5541* (COL, INB, MO); **Cundinamarca:** sin datos, 1960 (fl), *Schultes 22707* (COL). **Magdalena:** Alto Río Frío, cabeceras del río Congo, Ciudad Antigua, 25 jul 1989 (fl), *Madriñan & Barbosa 456* (GH, MO). **Meta:** Guamal, vereda Montecristo, nacimiento del río Humadea, 14 dic 2004 (fl, fr), *L. Carvajal 440* (COL, UDBC). **Putumayo:** Villa Garzón, vereda Oroyaco, 29 abr 1997 (fl, fr), *López et al. 2914* (COAH). **Risaralda:** Pueblo Rico, corregimiento de Santa Cecilia, quebrada Cinto, 25 oct 1991 (fl), *Lozano et al. 6265* (COL). **Valle del Cauca:** Bajo Calima, concesión Pulpapel-Buenaventura, 28 nov 1984 (fl), *Monsalve 576* (COL, CUVC, JAUM, USF). **Vaupés:** E de Mitú, 18 nov 1945 (fl, fr), *Allen 3397* (K, MO, US). **Vichada:** Cumaribo, cerca de misión Santa Teresita, 16 dic 1993 (fl), *González & Cortez 9114* (COL, P).

Mandevilla vanheurckii (Müll. Arg.) Markgr., Notizbl. Bot. Gart. Berlin-Dahlem 9:87, fig. 2L. 1924. *Heterothrix vanheurckii* Müll. Arg., Observ. Bot. 164. 1871. *Eriadenia obovata* Miers, Apocyn. S. Amer. 117–118, t. 14 B. 1878, nom. superfl. TIPO: PERÚ. LORETO: cerca de Tarapoto, fecha perdida (fl), *R. Spruce 4303* (HOLOTIPO: W [foto F neg. 31792]; ISOTIPOS: BM, CGE, F [fragmento], G [foto F neg. 26855], K [2 pliegos], P).

Distribución y hábitat.—SE de Colombia, S de Venezuela y Perú, en vegetación asociada a afloramientos graníticos, en elevaciones de 250–300 m.

Esta especie se puede reconocer con facilidad por sus hojas obovadas a elíptico-obovadas, con las venas secundarias y terciarias no evidentes.

Especimenes representativos examinados: **Amazonas:** raudal Yayacopi (La Playa), 16 feb 1952 (fl), *Schultes & Cabrera 15393* (COL, GH, MO, US). **Caquetá:** sierra de Chiribiquete, campamento Norte, 7 dic 1990 (fl), *Castroviejo et al. 11984* (MA).

Mandevilla veraguasensis (Seem.) Hemsl., Biol. Centr.-Amer., Bot. 2:317. 1881. *Echites veraguasensis* Seem., Bot. Voy. Herald 168. 1852. TIPO: Panamá. Chiriquí: Boquete, mar 1848 (fl), *C. Seemann 1220* (HOLOTIPO: K; ISOTIPO: BM).

Mandevilla loeseneriana K. Schum., Bot. Jahrb. Syst. 25:725. 1898. TIPO: ECUADOR. PICHINCHA: río Pilatón, Sep 1891 (fl), *L. Sodiro 106/5* (HOLOTIPO: B [destruido, foto F neg. 4525]; LECTOTIPO, designado por Morales, Revista Acad. Colomb. Ci. Exact. 29:47. 2005: QPLS; ISOLECTOTIPOS: P, Q).

Distribución y hábitat.—Nicaragua a Venezuela y Perú, en bosques húmedos entre 1500–2100 m.

Mandevilla veraguasensis se puede reconocer por sus hojas cordadas basalmente, con los coléteres aglomerados en la base del nervio central y por sus corolas infundibuliformes, usualmente péndulas y con el tubo externamente blanco verdoso y lóbulos morados.

Especimenes representativos examinados: **Antioquia:** Betania, Farallones del Citará, paraje Las Canoas, quebrada La Bramadora, 12 nov 1997 (fr), *Fonnegra et al. 6669* (HUA, INB, MO). **Boyacá:** Chapón, NE de Bogota, 23 may 1932 (fl), *Lawrence 106* (F [2 pliegos], MO, S). **Cauca:** Juzza, Popayán, ene año perdido (fl), *Lehmann 8483* (F, K [2 pliegos]). **Cesar:** serranía del Perijá, Agustin Codazii, El Milagro, 28 may 1994 (st), *Rangel et al. 12539* (COL). **Cundinamarca:** estación Santana, cerca de Sasaima, 25 jun 1945 (fl, fr), *Dugand & Jaramillo 3839* (COL, MO, US). **Guajira:** Sierra Nevada de Santa Marta, Sierra de San Antonio, 19 ago 1986 (fl), *Cuadros & Gentry 2901* (MO, USF). **Huila:** La Argentina, vereda el Progreso, 9 jun 2005 (fl), *G. Silva et al. 180* (COL, FMB). **Magdalena:** El Campano, 10 jun 1993 (fl), *Gentry & Ortiz 79785* (INB, MO, SI). **Meta:** Villavicencio, 12 ene 1876 (fl), *André 1172* (K). **Nariño:** Ricaurte, reserva natural La Planada, entre Santa Rosa y la reserva, 20 feb 1993 (fl), *Betancur et al. 3938* (COL). **Quindio:** Córdoba, carretera Córdoba-Pijao, 10 Sep 1987 (fl), *Arbeláez et al. 2230* (COL, HUA, HUQ). **Santander:** Floridablanca-Tona, vereda El Mortiño, camino a Pamplona, 25 jun 2004 (fl), *Fernández-Alonso & Albesiano 21692* (COL). **Tolima:** entre El Eden a La Palmilla, 3 ago 1922 (fl), *Killip & Hazen 9620* (GH, NY, US). **Valle:** Cordillera Central, hoya del río Bigalagrande, Cebollal, 26 abr 1946 (fl), *Cuatrecasas 21008* (F [2 pliegos], COL, VALLE).

Mandevilla villosa (Miers) Woodson, Ann. Missouri Bot. Gard. 19:70. 1932. *Laseguea villosa* Miers, Apocyn. S. Amer. 250–251. 1878. Tipo: NICARAGUA: datos de localidad perdidos, 1848 (fl), *C. Seemann 95* (holotipo: BM; isotipo: K).

Echites comosus O. Kuntze, Revis. Gen. Pl. 2:414. 1891. Tipo: Panamá: Gale, fecha perdida (fl), *O. Kuntze 1891* (lectotipo, designado por Morales, An. Jard. Bot. Madrid 62:67. 2005: NY [fotocopia, INB]).

Distribución y hábitat.—S de México, Guatemala, El Salvador, Nicaragua al NE de Colombia, en bosques muy húmedos, entre 0–800 m.

Esta especie se puede confundir con *Mandevilla subsagittata*, pero se reconoce con facilidad por sus brácteas florales foliáceas (vs. escariosas). A pesar de tener una distribución geográfica amplia, es un taxón conocido por pocas colecciones de herbario.

Especimenes representativos examinados: **Antioquia:** Turbo, 21 ene 1974 (fl), *Gentry 9448* (COL, MO, Z); Turbo, 5 jun 1946 (fl), *Haught 4852* (COL, K, MO, US). **Chocó:** hoya del río San Juan, quebrada Taparal, 27 mar 1979 (fl), *Forero et al. 4200* (COL). **Córdoba:** Planeta Rica, Marañonal, Cerro Queresa, 26 oct 1990 (fl), *Roldán et al. 1504* (HUA, MO).

Mandevilla xerophytica J.F. Morales, Candollea 60:54, f. 4. 2004. Tipo: COLOMBIA. Boyaca: cercanías de Boavita, 16 sep 1938 (fl, fr), *J. Cuatrecasas 1932* (holotipo: F; isotipos: COL, US).

Distribución y hábitat.—Endémica a Colombia, creciendo en vegetación xerofítica, en elevaciones de 1700–2250 m.

Mandevilla xerophytica es similar a *M. longipes* Woodson, pero se reconoce por sus hojas con el envés pubescente y por las flores con los pedicelos y tubo de la corola más cortos.

Especimenes representativos examinados: **Boyacá:** Cordillera Oriental, hoya del río Chicamoya, entre Soatá y Tipacopque, 18 jul 1940 (fl, fr), *Cuatrecasas & García-Barriga 9826* (COL, F, MO, US)

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BOOK NOTICES

Two New Books on Pitcher Plants

STEWART MCPHERSON, ANDREAS WISTUBA, ANDREAS FLEISCHMANN, AND JOACHIM NERZ. 2011. **Sarraceniaceae of South America.** (ISBN 978-0-9558918-7-8, hbk.). Redfern Natural History Productions, 61 Lake Drive, Hamworthy, Poole, Dorset BH15 4LR, ENGLAND, UK. (**Orders:** inside UK 01202 686585, outside UK +44 1202 686585, www.redfernnaturalhistory.com, sales@redfernnaturalhistory.com). £34.99, 562 pp., 488 images, 6¼" x 9¼".

From the publisher: This work is part of an exquisitely beautiful and uniquely detailed two volume monograph that provides the first complete study of the full diversity, ecology and taxonomy of all recognised species of the three genera of Sarraceniaceae (*Darlingtonia*, *Heliamphora* and *Sarracenia*).

Sarraceniaceae of South America examines all species of *Heliamphora* from the Guiana Highlands of Venezuela, Brazil and Guyana, including five new *Heliamphora* species along with three incompletely diagnosed *Heliamphora* taxa that have not been documented previously.

Complete with up-to-date conservation assessments, distribution maps and accounts of the diversity, wild ecology and habitats of all species, this monograph is a major and definitive taxonomic revision of all three genera of true pitcher plants of the New World.

Visually beautiful and comprehensive, these books will appeal to both general readers and specialists who are interested in the natural history, diversity, ecology and relationships of *Darlingtonia*, *Heliamphora* and *Sarracenia*.

STEWART MCPHERSON AND DONALD SCHNELL. 2011. **Sarraceniaceae of North America.** (ISBN978-0-9558918-6-1, hbk.). Redfern Natural History Productions, 61 Lake Drive, Hamworthy, Poole, Dorset BH15 4LR, ENGLAND, UK. (**Orders:** inside UK 01202 686585, outside UK +44 1202 686585, www.redfernnaturalhistory.com, sales@redfernnaturalhistory.com). £34.99, 808 pp., 571 images, 6¼" x 9¼".

From the publisher: Sarraceniaceae of North America examines all species of *Darlingtonia* and *Sarracenia* from the United States and Canada, including eighteen new *Sarracenia* varieties and forms, one incompletely diagnosed *Sarracenia* taxon, and one new form *Darlintonia*.

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TRES NUEVAS ESPECIES DE *MELIOSMA* (SABIACEAE) PARA COSTA RICA Y PANAMÁ

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RESUMEN

Meliosma cresstolina, **M. laxiflora** y **M. oligantha**, tres nuevas especies de Costa Rica y Panamá son descritas e ilustradas. Se discuten las relaciones con especies similares.

PALABRAS CLAVE: Mesoamérica, Sabiaceae, *Meliosma*

ABSTRACT

Meliosma cresstolina, **M. laxiflora**, and **M. oligantha**, three new species from Costa Rica and Panama are described and illustrated. Relationships with similar species are discussed.

KEY WORDS: Mesoamerica, Sabiaceae, *Meliosma*

Meliosma (Sabiaceae) es un género pantropical con 80–90 especies, con un marcado centro de diversidad en el Neotrópico (Morales 2009). Todas las especies del Nuevo Mundo (con excepción de *M. alba* (Schltdl.) Walp.) pertenecen al subgénero *Meliosma* sección *Lorenzanea* (Van Beusekom 1971). Las especies neotropicales nunca han sido tratadas en una revisión taxonómica y solo se tienen sinopsis para regiones específicas (e.g., Morales 2003) o tratamientos florísticos para algunos países (e.g., Gentry 2001; Aymard & Cuello 2005). A pesar de ser un género pobremente estudiado, las especies son fácilmente diferenciables por caracteres morfológicos de las hojas (e.g., la forma e indumento de las láminas, número de venas secundarias, largo de los pecíolos) e inflorescencia (e.g., indumento, tipo y numero de ramificaciones, tamaño de los sépalos y pétalos) y en general, no se encuentran taxones polimórficos y con variaciones morfológicas extremas que hagan difícil la separación a nivel de especie. Adicionalmente, la forma y tamaño de los pétalos internos (ubicados en forma opuesta a las anteras) es un carácter que puede ayudar a separar los taxones, en adición a los caracteres antes mencionados. Las flores de *Meliosma* y sus partes (usualmente mal interpretadas) se muestran en la figura 1 (siguiendo lo establecido por Van Beusekom [1971]).

La mayoría de especies dentro del género tiene distribuciones restringidas a uno o dos países y muy pocas tienen distribuciones amplias (e.g., *M. glabrata* (Liebm.) Urb [México, Nicaragua, Costa Rica a Colombia, Ecuador y Perú], *M. dentata* (Liebm.) Urb. [México a Costa Rica]). Sin embargo, hay que tener cuidado en la determinación de material estéril, pues ante la carencia de flores o frutos muchos taxones son similares y se puede con facilidad cometer errores en su identificación.

Preparando una revisión de las especies de Norte y Centroamérica de *Meliosma* se ha realizado un estudio taxonómico y monográfico en los últimos 4 años, que ha incluido la revisión de todas los tipos de taxones descritos o reportados para esta área, así como el estudio de más de 900 ejemplares de herbario y trabajo de campo en 4 países diferentes con el fin de entender la variación morfológica intraespecífica. Como resultado de esta revisión, algunas novedades taxonómicas han sido publicadas recientemente (e.g., Menjivar et al. 2008; Morales 2009) y hasta la fecha se han contabilizado un total de 32 especies para esta región geográfica. El principal problema detectado es la incorrecta aplicación de nombres, tanto de especies no conocidas en México o Centroamérica, como de otras con distribuciones restringidas, pero cuyo nombre ha sido indiscriminadamente usado para especímenes estériles (e.g., *M. occidentalis* Cuatrec.).

Durante la preparación del tratamiento de Sabiaceae para la Flora Mesoamericana y el Manual de Plantas de Costa Rica, tres nuevas especies de *Meliosma* fueron encontradas. Por lo tanto, son descritas a continuación.

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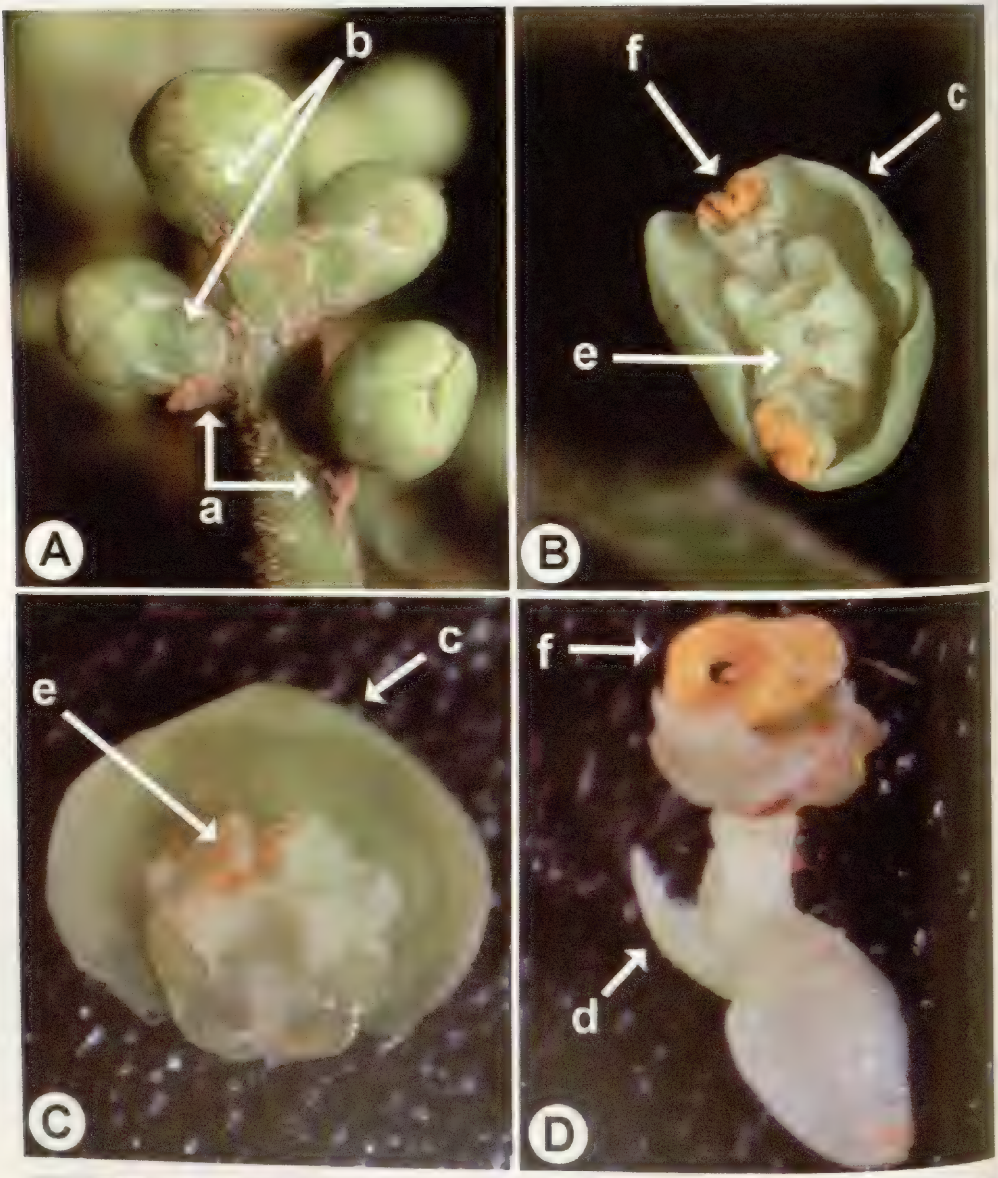

Fig. 1. Partes de una flor de *Meliosma irazuensis* Standl. (*J.F. Morales 19500*, INB). **A.** Botones florales. **B.** Corola durante la antésis. **C.** Vista adaxial de un pétalo externo y estaminodio removido de una corola. **D.** Vista lateral de un estambre con el pétalo interno. a. bracteolas. b. sépalos. c. pétalos externos. d. petalo interno. e. estaminodios. f. anteras.

En la discusion de las especies afines, algunos datos han sido tomados del tratamiento de Flora Mesoamericana (en preparacion), por lo que pueden diferir de los citados en otros tratamientos previos.

Meliosma cresstolina J.F. Morales, sp. nov. (**Fig. 2**). Tipo: COSTA RICA. Puntarenas: Buenos Aires, parque internacional La Amistad, Tres Colinas, 27 feb 2008 (fl), *D. Solano & D. Santamaria 5190* (holotipo: INB; isotipos: CR, MO).

A *Meliosma cordata* A.H. Gentry cui affinis, petiolis 1,6–3,4 cm longis (vs. (4,5–)5–10,4 cm) et foliis longiribus (22,9–36,7(–56,5) × 10,8–1? cm vs. 10,3–19,8 × 4,9–6,1 cm) differt.

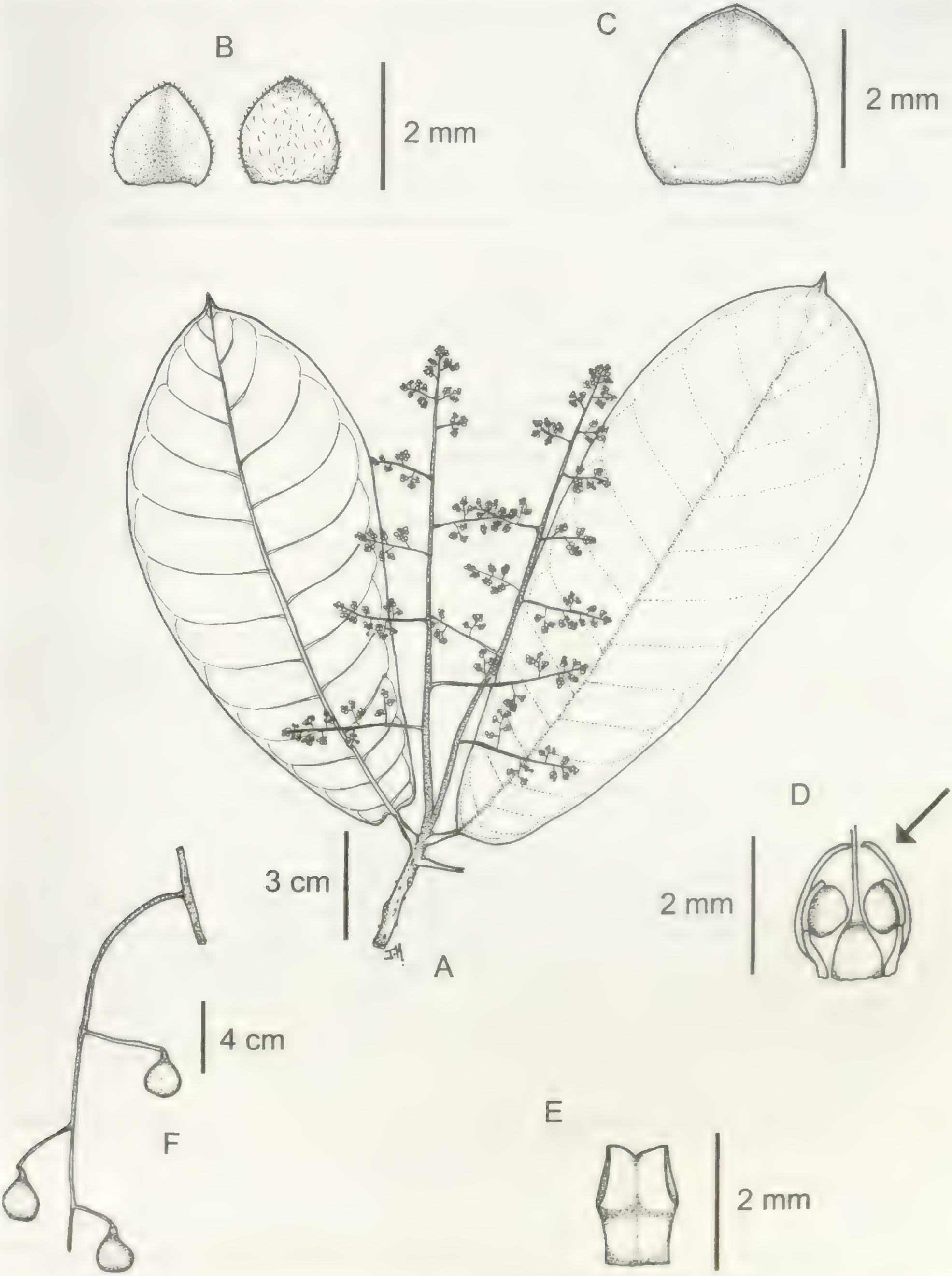

Fig. 2. *Meliosma cresstolina* (A–E de *Solano & Santamaría 5190*, INB; F de *Santamaría et al. 7281*, INB). **A.** Rama con inflorescencia. **B.** Sépalo, vista adaxial y abaxial. **C.** Pétalo externo, vista abaxial. **D.** Estambres, ovario y pétalos internos (uno señalado por una flecha). **E.** Estaminodio. **F.** Infrutescencia.

Árboles de 5–7 m de altura; tallos jóvenes densamente tomentulosos, pero rápidamente glabrescentes, los tallos viejos glabros o cerca de eso. Hojas con el pecíolo 1,6–3,4 cm de largo, densamente tomentuloso, pero glabrescentes; láminas 22,9–36,7(–56,5) × 10,8–15,5 cm, obovado-elípticas a obovadas, el ápice obtuso o redondeado y abrupta y cortamente cuspidado, la base redondeada a subtruncada, algunas veces levemente subcordada o oblicua, no revoluta, el margen entero, glabrescentes adaxialmente, el indumento denso y restringido sobre las nervaduras, moderadamente puberulentas en la superficie abaxial, con 16 a 20 pares de venas secundarias. Inflorescencias panículas tripinadas, 19–31 cm de largo, densamente tomentulosas; brácteas hasta 1,3 mm de largo; bracteólas 0,8–1,1 mm de largo. Flores densamente aglomeradas, sésiles; sépalos 5, de 1,6–1,8 mm de largo, anchamente ovados, el ápice obtuso, densamente puberulentos externamente, el margen ciliolado; pétalos blancos a blanco-verdosos, los 3 externos 2,4–2,6 de largo, glabros, los 2 internos 1,4–1,6 mm de largo, linear-ovados, ubicados dorsalmente sobre los filamentos y sobrepasándolos, glabros; estambres 5, pero solo 2 fértiles, las tecas 0,7–0,9 mm de largo, los estaminodios 1,6–1,7 mm de largo, subcuadrados, glabros; ovario glabro. Frutos 2,1–2,4 × 1,9–2,1 cm, piriformes.

Distribución, habitat y fenología.—Endémica a Costa Rica, donde se ha reportado que crece en bosques nubosos entre 1600–2200 m de elevación. Especimenes con flores se han recolectado entre febrero y marzo. Material con frutos se ha recolectado entre febrero y marzo y en septiembre.

Esta especie ha sido confundida con *Meliosma cordata* (Morales 2003), pero *M. cresstolina* se puede separar fácilmente por sus hojas con peciolos 1,6–3,4 cm de largo (vs. (4,5–)5–10,4 cm), con láminas foliares más grandes (22,9–36,7(–56,5) × 10,8–15,5 cm vs. 10,3–19,8 × 4,9–6,1 cm) y de forma ovada a ovado-elíptica (vs. obovado-elíptica a obovada) y con la base redondeada a subtruncada o algunas veces levemente subcordada o oblicua (vs. cordada). Adicionalmente, *M. cordata* tiene flores pediceladas, con pedicelos de 1,6–2,2 mm y crece en bosques húmedos o muy húmedos entre 700–1000 m (no se conoce aún de Costa Rica), mientras que *M. cresstolina* tiene flores sésiles y crece en bosques nubosos entre 1600–2200 m. *Meliosma cordata* es conocida hasta la fecha únicamente por dos colecciones (ambas sin flores), pero el resto de caracteres morfológicos son bien diferentes de *M. cresstolina*. Otras especies similares incluyen a *M. clandestina* J.F. Morales, pero esta última tiene pecíolos muy cortos, que usualmente no exceden los 5 mm de longitud (vs. 1,6–3,4 cm de largo), inflorescencias conspicuamente pendulosas (vs. erectas) y pétalos internos más cortos (1,1–1,2 mm vs. 1,4–1,6 mm).

Etimología.—El epíteto de esta especie es un anagrama del nombre de la localidad tipo, Tres Colinas.

Especímenes examinados: **COSTA RICA. Puntarenas:** parque internacional La Amistad, estación Tres Colinas,10 sep 1996 (fr), *Alfaro 740* (INB); Cordillera de Talamanca, Tres Colinas, 20 mar 1984 (fl), *Davidse et al. 25672* (INB, MO); Buenos Aires, Tres Colinas, río Guineo, 17 sep 1996 (fr), *Gamboa & Picado 649* (INB, MO); Buenos Aires, parque internacional La Amistad, La Lucha, 24 feb 2008 (fl), *Rodríguez et al. 11917* (INB); Buenos Aires, parque internacional La Amistad, 3–4 km del cerro Amuo, 22 feb 2008 (fr), *Santamaría et al. 7081* (INB); parque internacional La Amistad, entre Rancho Amuo y Cerro Seco, 25 feb 2008 (fr), *Santamaría et al. 7214* (INB, MO); parque internacional La Amistad, Tres Colinas, sendero al cerro Kámuk, 27 feb 2008 (fr), *Santamaría et al. 7281* (INB); parque internacional La Amistad, cerro Amuo, 20 feb 2008 (fl), *Solano et al. 4987* (INB, MO); Buenos Aires, parque internacional La Amistad, La Lucha, 22 feb 2008 (fl), *Solano et al. 5062* (INB, MO); parque internacional La Amistad, La Lucha, Potrero Grande, 25 feb 2008 (fr), *Solano et al. 5163* (INB); parque internacional La Amistad, 26 feb 2008 (fl, fr), *Zamora & Solano 4080* (INB, MO).

Meliosma laxiflora J.F. Morales, sp. nov. (**Fig. 3**). Tipo: COSTA RICA. Puntarenas: cantón de Osa, reserva forestal Golfo Dulce, Sierpe, playa Campanario (San Josecito), 12 oct 1991 (fl), *P. Harmon 273* (holotipo: INB).

A *Meliosma glabrata* (Liebm.) Urb. cui affinis, petalis minoribus et fructis minoribus (1,7–1,8 vs. 2,3–2,6 cm) differt.

Árboles de 4–5 m de altura; tallos moderamente puberulentos cuando jóvenes, pero rápidamente glabrescentes, los tallos viejos glabros o cerca de eso. Hojas con el pecíolo 0,4–1,4 cm de largo, inconspicuamente puberulento o glabrescente; láminas 11,6–22,6 × 3,2–4,9 cm, obovadas a angostamente obovado-elípticas, el ápice cortamente acuminado, la base angostamente cuneada, no revoluta, el margen subentero a inconspicuamente dentado distalmente, prácticamente glabras, con 19 a 23 pares de venas secundarias. Inflorescencias panículas débilmente tripinadas, 19–22 cm de largo, diminutamente puberulentas; brácteas hasta 1,3 mm de largo; bracteolas hasta 0,7 mm de largo. Flores laxamente dispuestas, sésiles a subsésiles, con pedicelos (cuando presentes) hasta 1 mm de longitud; sépalos 5, de 0,8–1,2 mm de largo, anchamente ovados, el ápice redondeado

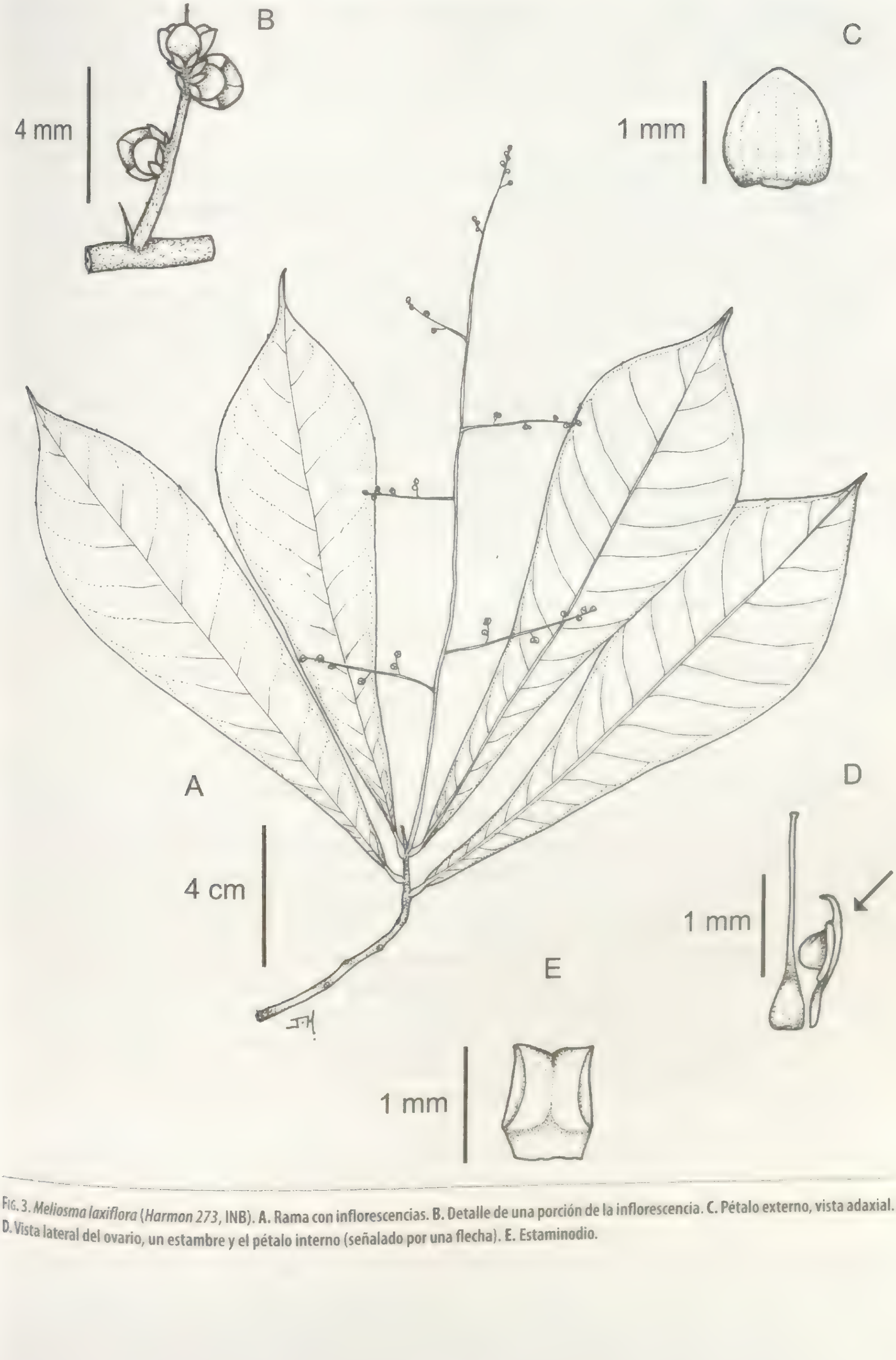

FIG. 3. *Meliosma laxiflora* (*Harmon 273*, INB). **A.** Rama con inflorescencias. **B.** Detalle de una porción de la inflorescencia. **C.** Pétalo externo, vista adaxial. **D.** Vista lateral del ovario, un estambre y el pétalo interno (señalado por una flecha). **E.** Estaminodio.

a obtuso, glabros externamente, pero el margen diminutamente ciliolado; pétalos verde-crema, los 3 externos 1,6–1,7 mm de largo, glabros, los 2 internos 0,8–1,1 mm de largo, linear-ovados, glabros, ubicados dorsalmente en la base del filamento y sobrepasandolo; estambres 5, pero solo 2 fértiles, las tecas ca. 0,4 mm de largo, los estaminodios 0,7–0,8 mm de largo, subcuadrados, glabros; ovario glabro. Frutos 1,7–1,8 × 1,5–1,6 cm, piriformes.

Distribución, habitat y fenología.—Endémica a Costa Rica, donde crece en bosques muy húmedos en elevaciones de 0–200 m. Especimenes con flores se han recolectado en julio y octubre. Frutos se reportan en julio.

Siguiendo el tratamiento de Morales (2003) para las especies de Costa Rica y Panamá, *Meliosma laxiflora* se puede confundir con *M. glabrata* (Liebm.) Urb., (conocida de México y de Nicaragua a Colombia, Ecuador y el N de Perú), ya que ambas especies comparten hojas con formas similares e inflorescencias débilmente tripinnadas, Sin embargo, *M. laxiflora* pero se puede reconocer por sus hojas con más pares de venas secundarias (19–23 vs. 13–18), inflorescencias con las flores laxamente dispuestas (vs. densamente aglomeradas), flores con los pétalos externos 1,6–1,7 mm de largo (vs. 2,2–2,4 mm) y frutos más pequeños (1,7–1,8 vs. 2,3–2,6 cm). Adicionalmente, los pétalos internos de *M. laxiflora* son más pequeños (0,8–1,1 mm vs. 1,7–1,9 mm) y no sobrepasan los filamentos (vs. conspicuamente sobrepasando los filamentos) y es una especie que crece en ecosistemas costeros y zonas bajas, que no sobrepasan los 200 m de elevación (vs. bosques en cordilleras sobre los 400 m de elevación) El estudio de los árboles ubicados en la localidad tipo, revelan que *M. laxiflora* siempre tiene frutos muy pequeños, en comparación con *M. glabrata*, un taxón que he podido estudiar ampliamente en las cordilleras de Guanacaste y Tilarán y que tiene frutos mucho más grandes.

Etimología.—El epíteto de esta especie hace referencia a las inflorescencias con las flores laxamente distribuidas.

Especímenes examinados: **COSTA RICA. Puntarenas:** parque nacional Corcovado, Llorona, 13 jul 1977 (fl, fr), *Liesner 3227* (INB, MO); reserva forestal Golfo Dulce, Sierpe, playa Campanario, 10 jul 2003 (fr), *Morales 19503* (INB).

Meliosma oligantha J.F. Morales, sp. nov. (**Fig. 4**). Tipo: PANAMÁ. Panamá: parque nacional Altos de Campana, sendero al cerro de La Cruz, 6 may 1993 (fl), *M. Correa & E. Montenegro 9517* (holotipo: MO; isotipo: INB).

A *Meliosma grandiflora* C.V. Morton ex A.H. Gentry cui affinis, sepalis minoribus (1–1,2 mm vs. 1,5–2 mm longis), petalis extus minoribus (1,8–2 mm vs. 4,8–5,2 mm longis) et fructis minoribus (1,7–1,8 cm vs. 2,1–2,5 cm longis) differt.

Árboles o arbustos de 3,5–10 m de altura; tallos inconspicuamente puberulentos cuando jóvenes, pero rápidamente glabrescentes, los tallos viejos glabros. Hojas con el pecíolo 0,4–1 cm de largo, generalmente glabro; láminas 3,6–10,7(–12) × 1,9–6,1 cm, elípticas a ovadas, el ápice agudo a cortamente acuminado, la base anchamente aguda a obtusa, de manera menos usual redondeada, no revoluta, el margen entero, usualmente glabras, con 8–12 pares de venas secundarias. Inflorescencias espiciformes, 1–pinnadas o inconspicuamente bipinadas, 0,5–1,7 cm de largo, glabras; brácteas 0,6–0,8 mm de largo; bracteólas 0,3–0,8 mm de largo. Flores por lo general algo aglomeradas, subsésiles o cortamente pediceladas y con pedicelos hasta ca. 1,5 mm de largo; sépalos 5, de 1–1,2 mm de largo, anchamente ovados a suborbiculares, el ápice redondeado a obtuso, glabros externamente, pero el margen diminutamente ciliolado; pétalos amarillos a blanco-verdosos, los 3 externos 1,8–2 mm de largo, glabros, los 2 internos 0,4–0,7 mm de largo, ubicados dorsalmente sobre los filamentos, pero no sobrepásandolos, linear-elípticos, glabros; estambres 5, pero solo 2 fértiles, las tecas 0,3–0,4 mm de largo, los estaminodios 0,7–0,8 mm de largo, subrectangulares, glabros; ovario glabro. Frutos 1,7–1,9 × 1,4–1,6 cm, subpiriformes.

Distribución, habitat y fenología.—Restringida a Costa Rica y Panamá, en bosques muy húmedos o nubosos, en elevaciones de 300–1600 m. Especimenes con flores se han recolectado entre mayo y julio. Frutos se han recolectado en abril, junio y diciembre.

En el género *Meliosma* predominan las inflorescencias cimosas y con ramificaciones evidentes (bi-o tripinnadas) y la presencia de inflorescencias espiciformes es bastante inusual. *Meliosma oligantha* junto con *M. grandiflora* C. V. Morton ex A. H. Gentry (de Costa Rica y el O de Panamá) son los únicos dos taxones que tienen este tipo de inflorescencias en Centroamérica y México. Ambas especies pueden confundirse con facilidad, ya que ambas comparten hojas de dimensiones similares, así como inflorescencias con pocas flores, pero

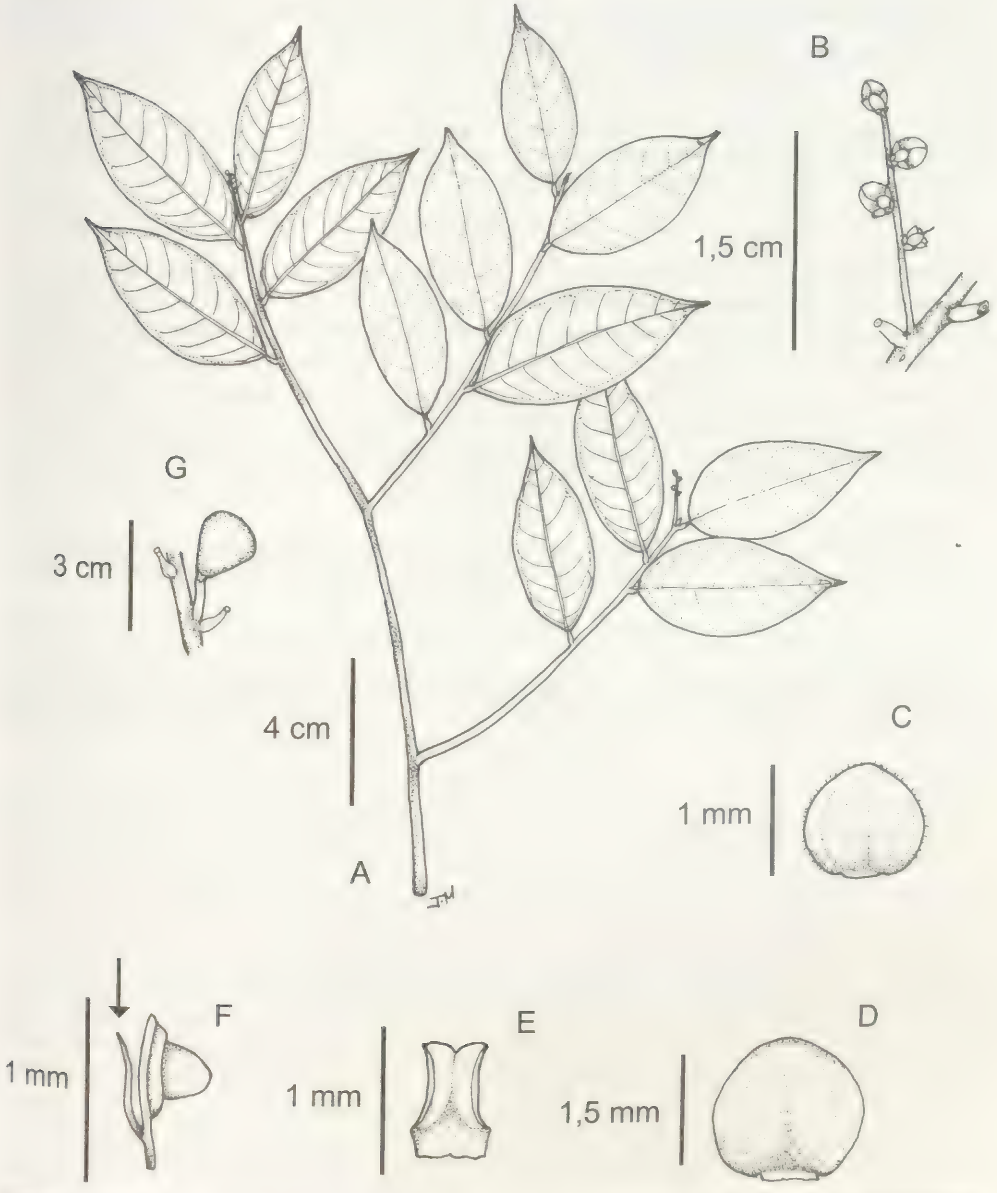

FIG. 4. *Meliosma oligantha* (A–F from *Correa & Montenegro*, INB; G from *González 3499*, INB). A. Rama con inflorescencias. B. Detalle de una inflorescencia. C. Vista adaxial de un sépalo. D. Pétalo externo, vista adaxial. E. Estaminodio. F. Vista lateral de un estambre y pétalo interno (señalado por una flecha). G. Fruto.

M. oligantha se puede reconocer por sus flores mucho más pequeñas, con sépalos de 1–1,2 mm de largo (vs. 1,5–2 mmm), pétalos externos de 1,8–2 mm de largo (vs. 4,8–5,2 mm) y frutos más pequeños (1,7–1,9 cm vs. 2,1–2,5 cm). Es importante recordar que *M. grandiflora* tiene los pétalos más grandes reportados hasta la fecha dentro del género.

Etimología.—El epíteto de esta especie hace referencia a las inflorescencias con pocas flores.

Especímenes examinados. **COSTA RICA. Alajuela:** Monteverde, cerca de la división Continental, 13 dic 1976 (fr), *Dryer 1054* (CR). **San Jose:** Tarrazú, Bajo de la Virgen, camino a cerro de Quepos, cruce con el río Negro, 18 abr 2003 (fr), *González 3499* (INB).
PANAMÁ. Panamá: parque nacional Altos de Campana, sendero que conduce hacia la cima de los cerros Campana, 1 jun 2011 (fl), *Carrión & Stapf 242* (PMA), 8 jun 2011 (fl, fr), *Carrión et al. 265* (PMA); parque nacional Altos de Campana, al E del campamento de los guardaparques, 18 jul 1991 (fl), *Correa et al. 7918* (MO); parque nacional Altos de Campana, sendero a cerro de la Cruz, 15 abr 1993 (fr), *Correa & Montenegro 9458* (MO); cerca de Cerro Jefe, entre Alto Pacora y cerro Brewster, 19 jun 1988 (fl, fr), *McPherson 12609* (MO)

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A TAXONOMIC TREATMENT OF *DALTONIA* (MUSCI: DALTONIACEAE) IN THE AMERICAS

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ABSTRACT

The moss genus *Daltonia* (Daltoniaceae) is revised for the Americas. This treatment recognizes eight species (*Daltonia bilimbata, D. jamesonii, D. lindigiana, D. macrotheca, D. marginata, D. ovalis, D. pulvinata*, and *D. splachnoides*) within this region. A key to the species, along with descriptions, images and distributional ranges are recorded for each species.

KEY WORDS: *Daltonia*, Daltoniaceae

RESUMEN

El género Daltonia (Daltoniaceae) fue revisado para las Américas. Este tratamiento reconoce ocho especies (*Daltonia bilimbata, D. jamesonii, D. lindigiana, D. macrotheca, D. marginata, D. ovalis, D. pulvinata*, y *D. splachnoides*) de esta región. Se incluye una clave para especies, descripciones, imágenes y distribución geográfica de cada especie.

Daltonia Hook. & Taylor was first published by Hooker and Taylor (1818) based on two taxa previously attributed to *Neckera* by Hedwig (1801) and Smith (1814). Later work uncovered that the name *Daltonia* was in fact illegitimate due to it containing the lectotype of an earlier described genus *Cryphaea* (Mohr in Weber 1813). For more information on the conservation of the name *Daltonia* consult Crosby (1968). Bridel (1827) recognized it as a monospecific genus consisting of *D. splachnoides*. Since Bridel-Brideri's treatment, well over 100 names have been attributed to *Daltonia*. Crosby et al. (2000) listed 60 species as being currently accepted, although many have not been reexamined since their original description.

Brotherus (1907, 1925), Fleischer (1908), Jaeger and Sauerbeck (1879) and Schimper (1855) classified *Daltonia* within a broadly defined Hookeriaceae. Miller (1971) removed *Daltonia* from the Hookeriaceae and raised it to the family level. Buck (1987, 1988), Buck et al. (2005), Crosby (1974) and Whittemore and Allen (1989) have maintained *Daltonia* within its own family although other genera incorporated within the family have fluctuated considerably. Currently *Daltonia* is classified as one of 14 genera within the family Daltoniaceae (Buck et al. 2005).

Species of *Daltonia* are distributed in the tropics to semi-tropics world-wide. They primarily occur at higher elevations on the trunks and branches of trees and to a much lesser extent on soil or rocks. They can be recognized by their generally small size, sparingly branched or unbranched gametophores, pinnately branched rhizoids, bordered, single costate leaves, and mitrate, ciliate calyptrae.

Measurements and description of leaves are those taken from the middle of the gametophore. Locality data and elevation listed in brackets [] is my best estimate when this is lacking from the information on the herbarium packet. Based on examination of material deposited at BM, BR, CANB, DUKE, E, EGR, FH, G, H, HIRO, JE, L, MELU, MO, NICH, NY, PC, S, U, and W, I recognize 8 species as occurring in the Americas: *D. bilimbata* Hampe, *D. jamesonii* Taylor, *D. lindigiana* Hampe, *D. macrotheca* Mitten, *D. marginata* Griffith, *D. ovalis* Taylor, *D. pulvinata* Mitten and *D. splachnoides* (Smith) Hooker & Taylor.

Daltonia Hook. & Taylor, Muscol. Brit. 80. 1818. *Neckera* sect. *Daltonia* (Hook. & Taylor) Wallr., Fl. Crypt. Germ. 1:217. 1831.

Plants small to medium-sized, small to large tufts. Stems ± erect, simple or branching irregularly, the branches not differentiated, evenly foliate; in cross section with orange, thick-walled cells surrounding larger, hyaline, thin-walled cells, central strand none; rhizoids usually confined to bases of stems but occasionally reaching

higher, smooth; pseudoparaphyllia none; axillary hairs (2–)4-celled, the basal one short, brown, the upper longer, hyaline. Leaves isophyllous, usually densely foliate, contorted or not, erect or spiraling about stem, variously shaped, ± symmetric, acute to acuminate, keeled; margins bordered by several rows of narrow, elongate cells, usually broader below, entire, plane or recurved; costa single, ending ½–⅘ the leaf length or rarely higher; cells variously shaped, smooth, colored or not across the insertion; alar cells not differentiated. Asexual propagula present or not, clustered at leaf base or at times occurring over the lamina or at leaf apex, elongate, fusiform or rarely muriform when larger. Autoicous or synoicous. Perichaetia small; leaves few, erect, ovate to ovate-lanceolate, acute to acuminate; margins obscurely bordered or not differentiated, entire or irregularly serrulate, plane or recurved; costa none or very weak, cells variously shaped. Setae elongate, papillose in upper portion, or rarely throughout or ± smooth; capsules erect to ± inclined, ovoid to ± cylindrical; exothecial cells quadrate to rectangular or irregular, collenchymatous or not; annulus none; operculum conic-rostrate; peristome double, attached near the mouth, yellow to light orange, exostome teeth triangular, not bordered or shouldered, recurved or ± erect, papillose to spiculose throughout, on front surface with a straight to ± zig-zag median line, perforate or not, not furrowed; endostome papillose to spiculose, basal membrane low, segments linear, ca. as long as the teeth, cilia none. Spores spherical, papillose or ± smooth. Calyptrae mitrate, ciliate at base, naked, smooth to ± roughened above.

KEY TO THE SPECIES

1. Leaves erect and not much contorted.
    2. Mature leaves generally ≤ 2.25 mm long.
        3. Leaf apex ± acute; elongate juxtacostal cells not evident; upper portion of seta noticeably papillose or rarely ± smooth ______ **D. splachnoides**
        3. Leaf apex cuspidate to attenuate; elongate juxtacostal cells (sometimes emerging from the end of the costa) usually noticeably evident; seta ± smooth ______ **D. ovalis**
    2. Mature leaves generally > 2.5 mm long.
        4. Leaf border not much distinguishable in shape or color from basal lamina cells; leaves ± linear-lanceolate ______ **D. lindigiana**
        4. Leaf border and laminal cells noticeably distinguishable from each other; leaves not linear-lanceolate.
            5. Leaf border very broad from base to ca. midleaf; elongate juxtacostal cells lacking ______ **D. bilimbata**
            5. Leaf border not strong beyond the basal area; elongate juxtacostal cells usually evident in some portion of the lamina ______ **D. ovalis**
1. Leaves not erect or if ± erect somewhat contorted.
    6. Laminal cells ± lenticular throughout ______ **D. marginata**
    6. Laminal cells not lenticular throughout.
        7. Leaf cells ± rectangular to quadrate to near the apex ______ **D. jamesonii**
        7. Leaf cells not rectangular or squarrose beyond mid leaf.
            8. Leaves oblong-lanceolate to ligulate, ± horizontally arranged around stem; hyaline propagula frequently present ______ **D. pulvinata**
            8. Leaves ± linear to ovate-lanceolate, usually somewhat constricted above base, border easily frayed, not horizontally arranged around stem, ± lax, exposing the stem to view; hyaline propagula not usually present ______ **D. macrotheca**

1. Daltonia bilimbata Hampe, Linnaea 32:151. 1863. (**Fig. 1**). PROTOLOGUE: COLOMBIA: Cundinamarca, Bogotá, Monserate, 2800 m, *Lindig 2056a* (BM!).

Daltonia compressa Mitt., J. Linn. Soc., Bot. 12:400. 1869. PROTOLOGUE: COLOMBIA: Andes Bogotenses, *Weir 349* (FH!, NY!, S!).

Daltonia peruviana Mitt., J. Linn. Soc., Bot. 12:401. 1869. PROTOLOGUE: PERU: Andes Peruvianae, Cordillera de Raneo, Sachapata. *Lechler* s.n. (NY!), *syn. nov.*

Daltonia subirrorata Broth., Biblioth. Bot. 87:129. 1916. PROTOLOGUE: BOLIVIA: Incacorral, alt. 2200 m, *Herzog 4950* (H-BR!, W!). There is a collection from Leiden with *Herzog 4950* on the label from the same location and data as the collection at H-BR but with the name *D. trachydonta* on the label. It contains only *D. marginata*. The collection from Vienna containing the type material. contains mostly *D. marginata*, but has also three stems of *D. bilimbata*. The material from H-BR consists of only one plant of *D. bilimbata*.

Plants medium-sized, bright yellow to yellow-green, in small to large tufts. Stems 5–15 mm high, not much branched. Leaves laxly erect, ± flexuose when dry, erect to erect-spreading when moist, 2.25–4 mm long, oblong-lanceolate, acute; margins narrowly revolute on one or both sides, border ± confluent at apex, 0–2 cells wide above, 10–16 cells wide at base (sometimes narrower in small plants); costa ending ca. ¾–⅘ the leaf length; upper cells short-linear to ± rhombic, median cells short-rectangular to short-linear, basal cells rectangular, ± quadrate, cells at insertion mostly concolorous with laminal cells or sometimes light orange. Asexual

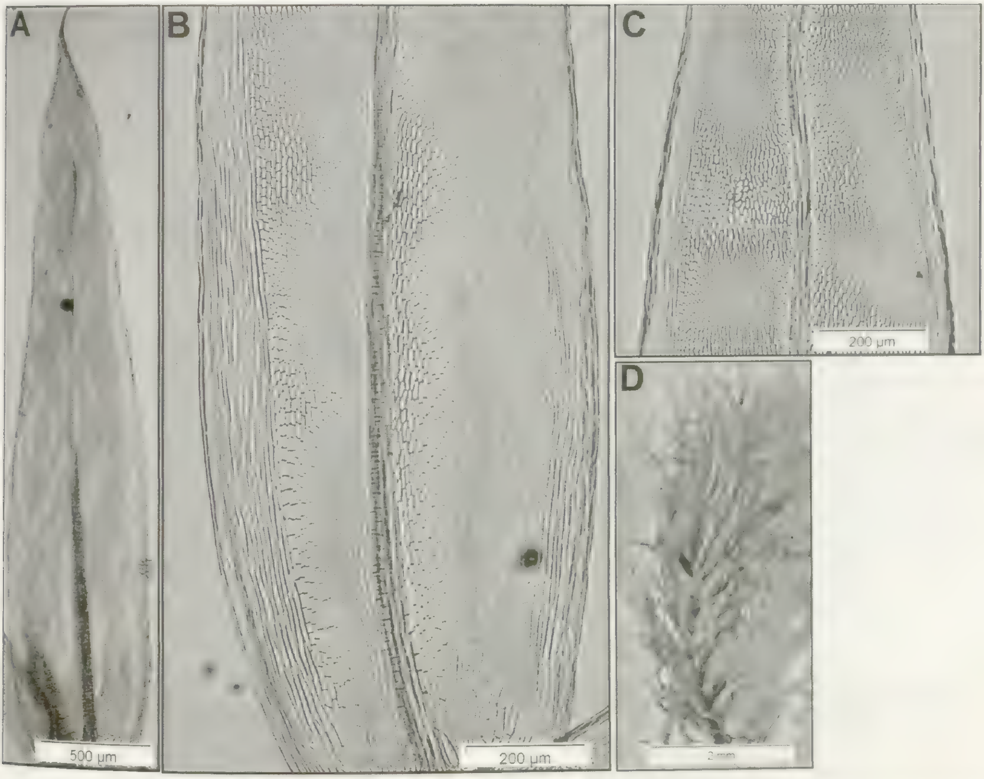

FIG. 1. *Daltonia bilimbata*. A. leaf outline; B. bottom half of leaf showing border and laminal cells; C. upper portion of leaf; D. habit.

propagula medium-large (70–170 µm), hyaline, fusiform. Setae elongate, smooth to slightly roughened in upper portion, red, 8–16 mm long, lightly twisted; capsules brown to bronze, ovoid-cylindric, 1–1.2 mm long; exothecial cells thick-walled, quadrate in upper portion, ± rectangular near base of urn; exostome teeth yellow, papillose to spiculose throughout; endostome segments yellow, papillose throughout. Spores finely papillose, 14–19 µm diam.

Daltonia bilimbata with its broad, basal border (quite distinct from the inner laminal cells) is unlikely to be confused with other members of the genus. The inner basal cells are somewhat reminiscent of those of *D. ovalis* and *D. pulvinata* in their generally quadrate nature but otherwise distinct from those species.

In overall leaf shape *D. bilimbata* and *D. marginata* are fairly similar when viewed under the microscope but the cell shape (consistently oval throughout in *D. marginata*) along with the generally contorted nature of the *D. marginata* plants when dry will easily separate the two. When plants of *D. pulvinata* are on the large size they can exhibit a broad border like *D. bilimbata* and both exhibit roughly similar cell patterns throughout the lamina. This could lead to confusion but plants of *D. pulvinata* have leaves that are almost always somewhat spiraling about the stem while plants of *D. bilimbata* generally have leaves that are erect. A collection from Panama (*Allen 9062*, MO) is a good example, with both species occurring in the same collection.

When plants of *D. bilimbata* are on the small size the border is not as pronounced and the leaves may somewhat resemble those of *D. macrotheca*. Characters useful in separating these two taxa are the more globose, brown capsule of *Daltonia bilimbata* versus a more conical shaped, greenish tinged urn (before fully mature) in *D. macrotheca*. Also the leaves of *D. bilimbata* tend to be more erect and closer appressed than those of *D. macrotheca* which tend to be somewhat contorted and wider spaced so that the stem is usually visible.

Daltonia bilimbata inhabits roughly the same type habitats and elevational ranges as the two most common species in the Western Hemisphere, *D. marginata* and *D. splachnoides*, and it is not uncommon to find either or both in collections containing *D. bilimbata*.

Illustrations.—Fig. 1; Bartram (1931, Pl. 4 figs. 11, 13 (as *D. peruviana*).

Habitat.—Epiphytic on canopy twigs and tree trunks between 2200–3200(–3680) m.

Representative specimens examined: **BOLIVIA. Cochabamba:** Chapare, Canton Tablas, Camino a Tablas, ca. 8 km N de carratera nueva (Cochabamba/Santa Cruz), 17°07'S, 65°54'W, 2550 m, *Churchill et al. 21083* (MO). **BRAZIL. Espirito Santo:** Serra de Caparao National Park, 20°30'S, 41°48'W, 2500 m, *Schäfer-Verwimp & Verwimp 11502* (MO). **COLOMBIA. Boyacá:** Nueva Granada, Monserate, [5°49'N, 73°35'W, 2800 m], *Lindig s.n.* (L); Cundinamarca: Paramo between Cogua and San Cayetano, Laguna Verde, [5°11'N, 74°02'W], 3680 m, *Cleef 6401a* (U); Nariño: Municipio Pasta between km 29–30 on Pasto-San Francisco road (Putumayo), 1°10'N, 77°07'W, 3300 m, *Churchill & Rengifo M. 17538-B* (NY). **COSTA RICA. Cartago:** just SE of summit of Cerro de la Muerte ridge, 45.7 km SE of El Empalme (3.2 km W of W entrance to Villa Milla), 8°36'N, 83°46'W, 3050 m, *Crosby 13132A* (MO); San José: La Palma area on regional road 220 beyond San Jerónimo, 10°03'N, 83°59'W, 1640 m, *Crosby & Crosby 5895A* (MO). **ECUADOR. Carchi:** 8 km from Julio Andrade, 0°39'N, 77°43'W, 3000 m, *Sastre-DeJesús 723* (NY); Loja: Parque Nacional Podocarpus, 6–7 km SE of park entrance along Hwy 39, S of city of Loja, 4°03'S, 79°10'W, 2700 m, *Buck 39536* (NY). **Pichincha:** Cordillera Occidental, Río El Cinto below Lloa, S slope Volcán de Pichincha, 0°15'S, 78°37'W, 2770 m, *Steere 26994* (NY); Tungurahua: Montana Agoyan, 10 km E of Banos, 1°23'S, 78°22'W, 2000 m, *Holm-Nielsen & Jeppesen 253* (U). **HONDURAS. Olancho:** Sierra de Algalta, Montana Babilonia. La Picucha & saddle between peaks, 13 km NNW of Catacamas, 14°57'N, 85°55'W, 2354 m, *Allen 12736A* (MO). **MEXICO. Puebla:** between Acapulco and Cuetzalan, [19°30'N, 98°00'W], 1500 m, *Sharp et al. 1097b* (MO). **PANAMA. Bocas del Toro:** Cerro Colorado, 4.3 mi above Chami camp, 8°35'N, 81°45'W, 1700 m, *Allen 5249A* (MO). **Chiriquí:** along road to summit of Volcán Baru, 8°45'N, 82°30'W, 3000 m, *Allen 9062* (MO). **PERU. Amazonas:** Chachapoyas,Chanchillo, 42 km behind Balsas in the direction of Leimebamba, [06°45'S, 77°54'W], 3200 m, *Hegewald & Hegewald 6747a* (MO). **Ayacucho:** Huanta, 25 km from Tapuna in direction of Ayna (30 km from Ayna), [12°44'S, 73°28'W], 2200 m, *Hegewald & Hegewald 9034* (MO). **Cajamarca:** Cajamarca, low bridge (Chalchuayacu) between Encanada and Celedin, [06°58'S, 78°15'W], 3550 m, *Hegewald & Hegewald 6616* (MO). **VENEZUELA. Merida:** Distrito Libertador, El Valle, a 12 kms NE from Merida, Quebrada de La Cana, 08°36'N, 71°09'W, 2400 m, *Griffin et al. 38* (MO).

2. Daltonia jamesonii Taylor, London J. Bot. 7:283. 1848. (**Fig. 2**). Protologue: ECUADOR: Pichincha, summit of Mt. Pichincha, 1847, *Jameson s.n.* (FH!).

Daltonia jamesonii var. *laevis* Herzog, Biblioth. Bot. 87:128. 1916. Protologue: [BOLIVIA]: Auf schwarzer Erde an feuchten Felsen der Cerros de Malaga, ca. 4000 m, *Herzog 4415* (FH!, JE!), *syn. nov.*

Plants small to large, golden-brown to bronze or black, in small to rather large tufts. Stems stiffly erect, simple or with a few erect branches, orange to orange-red, (10–)20–60 mm high, branching irregularly. Leaves imbricate, noticeably contorted when dry, ± helically spiraling at apex of stem, erect with flexuose tips and not much contorted when moist, (1.1–)1.4–2.6 mm long, broadly ovate, abruptly acuminate; margins narrowly revolute throughout, border ± confluent at apex or ending subpercurrently, 0–3 cells wide above, 4–16 cells wide at base; costa ending ca. ¾–⅚ the leaf length; upper cells short-rhombic, firm-walled, median cells quadrate to short-rectangular, basal cells rectangular to quadrate, orange across the insertion, ± concave on both surfaces (seen in cross-section). Asexual propagula medium-sized (ca. 50–60 μm), sparse, orange-red, muriform, occurring over lamina. Setae elongate, smooth, orange-dark red, 12–20(–25) mm long, lightly twisted at apex; capsules erect, maroon, ovoid-cylindric, 1–2 mm long; exothecial cells irregular to ± quadrate or hexagonal, firm-walled; exostome yellow, densely papillose throughout; endostome segments yellow, densely papillose throughout, perforate to ± eroded on the inner surface. Spores finely papillose, 17–25 μm diam.

Daltonia jamesonii is very distinctive from the other members of *Daltonia* occurring in the New World. The plants generally are found growing in rather large tufts, matted together at the base. All collections examined in the New World except one were taken from elevations of 4000 m or greater.

The deeply keeled leaves form a broad median fold when viewed under the microscope. The quadrate arranged, rather large cells compose the bottom ⅔ of the lamina before giving way to short, rhomboidal cells above. In cross section the cells of the lamina are somewhat concave on both surfaces. Other members of the genus exhibit flat or slightly convex surfaces on the cell walls.

Morphologically *D. jamesonii*, particularly when on the small side, resembles *D. himalayensis* from India and SE Asia. The collections of *D. himalayensis* that I have examined were generally taken from elevations lower (2400–3500 m) than those where *D. jamesonii* is found and most were growing on twigs while *D. jameso-*

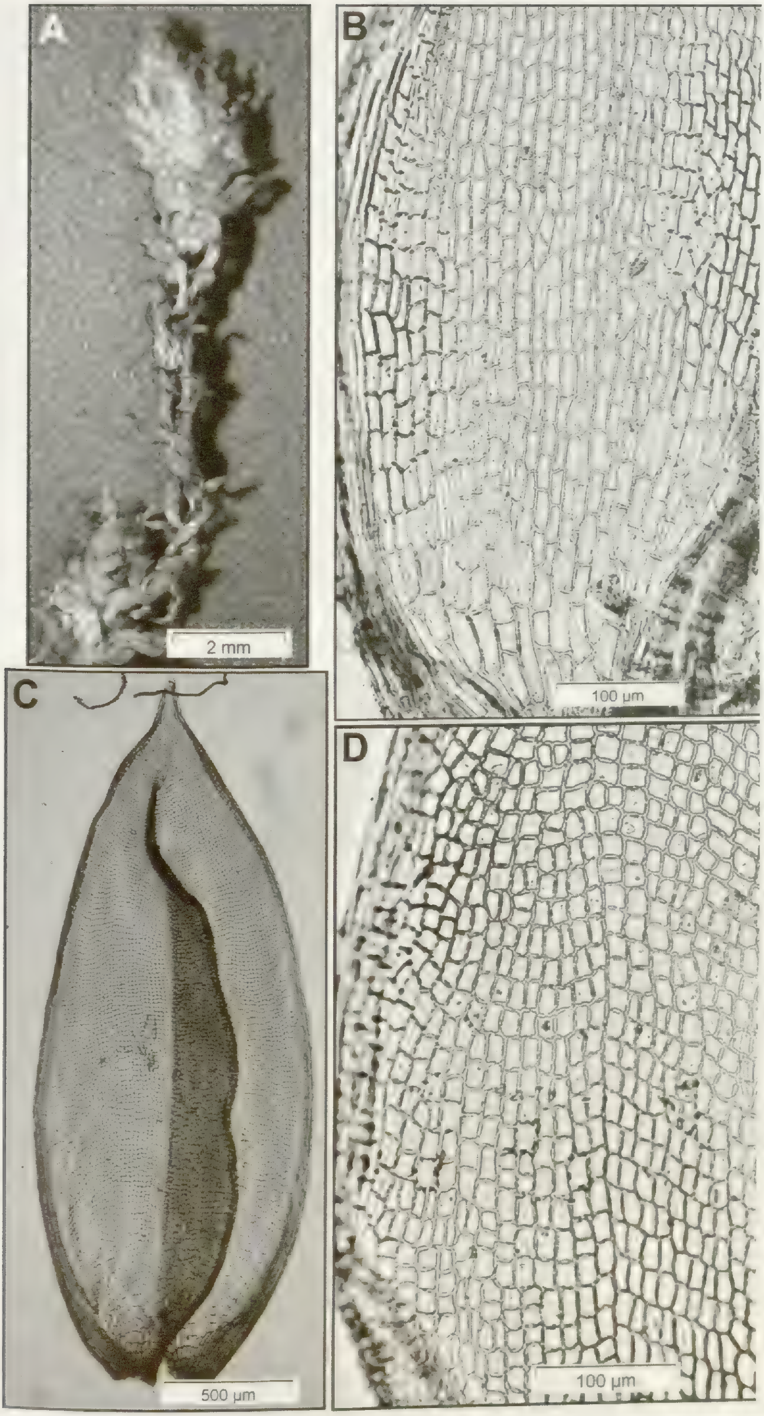

FIG. 2. *Daltonia jamesonii.* A. habit; B. lower portion of leaf; C. leaf outline; D. middle portion of leaf.

nii is primarily a rock dwelling or terrestrial moss. The only other *Daltonia* consistently found at elevations typically occupied by *D. jamesonii* is *D. ovalis*. These two are easily distinguished from one another by the elongate juxtacostal cells in *D. ovalis* as well the substrate on which each is generally found. The only collections of *D. jamesonii* that I have examined outside of the Andean region were collected in Papua New Guinea on similar substrates and at high elevations (3550–4200 m).

Illustrations.—Fig. 2; Bartram (1931, Pl. 3 fig. 8).

Habitat.—On rocks (volcanic, bedrock) or terrestrial, occurring in páramos and punas or high elevational bogs, at (3730–)4000–4700 m.

Representative specimens examined: **BOLIVIA. Cochabamba:** Cerros de Malaga, [18°24'S, 65°35'W], 4000 m, *Herzog 4415* (JE, L). **La Paz:** Inquisivi Cumbre Sayaguira. Headwaters of Rio Sayaguira, ca. 2.5 km S of Estancia Huana Hkota, [17°03'S, 67°17'W], 4650 m, *Lewis 87373* (L, MO, U); Prov. Larecaja, Nevado Jankho Uma, above Mina St. Antonio, across canyon from Millipaya, [15°51'S, 68°34'W], 4500 m, *Lewis 79-1537* (MO, NY). **COLOMBIA. Boyacá:** Cordillera Oriental, Siera Nevada del Cocuy, Alto Ritacuva, [6°25'N, 72°27'W], ca. 4600 m, *Barclay & Juajibioy 7349* (MO); Sierra Nevada del Cocuy, Páramo Concavo. 3.5 km al NNW del morro Pulpito del Diablo, [7°07'N, 72°43'W], 4335 m, *Cleef 8540b* (U). **Caldas:** Nevado del Ruiz, 4 km NNE of the cone of Volcano La Olleta, [4°54'N, 75°22'W], 4150 m, *Cleef & Florschutz 6004* (U). **Nariño:** Municipio de Túquerres, Páramo del Volcán Azufral [1°04'N, 77°41'W], 3730 m, *Ramírez P. 6850* (NY). **ECUADOR. Pichincha:** summit of Mt. Pichincha, [00°10'S, 78°36'W], 4690 m, *Jameson s.n.* (FH).

3. Daltonia lindigiana Hampe, Ann. Sci. Nat., Bot. V, 4:363. 1865. (**Fig. 3**). PROTOLOGUE: COLOMBIA: Cundinamarca, Bogotá, Boqueron, 2700 m, Jul 1859, *Lindig 2023* (BM!, H-BR!, L!, NY!)

Daltonia irrorata Mitt., J. Linn. Soc., Bot. 12:399. 1869. PROTOLOGUE: COLOMBIA: Andes Bogotenses, Boqueron prope Bogotá infra rupium stillicidia, ad ramulos emortuos saxaque (8500 ped.), *Weir 193, 294, 336, 338* (SYNTYPE: NY!).

Daltonia stenophylla Mitt., J. Linn. Soc., Bot. 12:402. 1869. PROTOLOGUE: ECUADOR: Andes Quitensis, in montibus Tungurahua (8000 ped.). *Spruce 568* (BM!, E!, H-SOL!, NY!), *syn. nov.* Mitten cites two collections by *Spruce* (#567, #568) in the original description. The description does not in my opinion give a clear indication as to what plant he was talking about as both *D. lindigiana* and *D. splachnoides* are both present along with *D. marginata* in the collection at BM. From the key I believe it is reasonable to assume he was referring to *D. lindigiana*. The type collections at NY contain *D. splachnoides* (#567) and *D. lindigiana* (#568) in one envelope and another packet above these contains an additional #568 which contains *D. splachnoides*. The larger #568 collection at BM contains *D. lindigiana, D. marginata* and *D. splachnoides*. The smaller #568 envelope contains only *D. splachnoides*. The #568 collection at H-SOL contains both *D. lindigiana* and *D. marginata*. The #568 collection at E contains only *D. lindigiana*.

Daltonia stenoloma Besch., Ann. Sci. Nat., Bot. VI, 10:277. 1881. PROTOLOGUE: LA RÉUNION: G. de l'isle; *Lèpervanche* (BM!, PC!). Arts (2005) moved this name from the synonymy of *D. angustifolia* var. *strictifolia* to *D. angustifolia* var. *angustifolia*. both of which I have placed in synonymy with *D. splachnoides*. The type fits well within my concept of *D. lindigiana*. The plants are much larger than those of *D. splachnoides* and they also have the characteristic hyaline gemmae so commonly seen in *D. lindigiana*.

Daltonia stewartii R.S. Williams, Bryologist 27:38. 1924. PROTOLOGUE: ECUADOR: Chatham Island, *Stewart 2782* (NY!).

Plants small to medium, yellow to golden brown, small to large tufts. Stems dark orange to maroon, (5–)10–45 mm high, branching irregularly. Leaves closely imbricate, nearly straight and erect when dry (rarely somewhat contorted in depauperate collections), ± spreading when moist, (1.5–)2–3 mm long, narrowly lanceolate, apex acute to acuminate; margins recurved on one or both sides throughout, borders ± confluent at apex, 0–3 cells wide above, 8–12 cells wide at base and not much distinguished from inner basal cells; costa ca. ¾ the leaf length or more; upper cells narrowly rhomboidal or somewhat lens shaped, median cells narrowly rhomboidal to linear, basal cells linear to long rectangular. Asexual propagula at times numerous, medium- (50–70 µm) to large-sized (90–110 µm), hyaline, spindle shaped, occurring at base of lamina. Setae elongate, smooth or quite scabrous, dark red, 10–12 mm long, shorter in reduced forms; capsules erect, golden brown, ovoid-cylindric, 0.75–1.0 mm long; exothecial cells subquadrate to mostly irregular, firm-walled; exostome teeth ± erect, yellow, densely papillose throughout, fenestrate along the entire length of the teeth with the exception of the basal region; endostome segments densely papillose throughout. Spores finely papillose to ± smooth, 13–1[illegible] µm diam.

Daltonia lindigiana is not likely to be confused with other members of the genus when the plants are larger, as those represented by the type collection of Lindig from Colombia. Confusion with *D. splachnoides* is likely when the plants are smaller. A suite of characters that are generally present even in the smaller plants that will help to separate the two are discussed below. *Daltonia lindigiana* has basal border cells and inner lamina cells that are not much differentiated in color or shape, whereas in *D. splachnoides* the basal border is generally

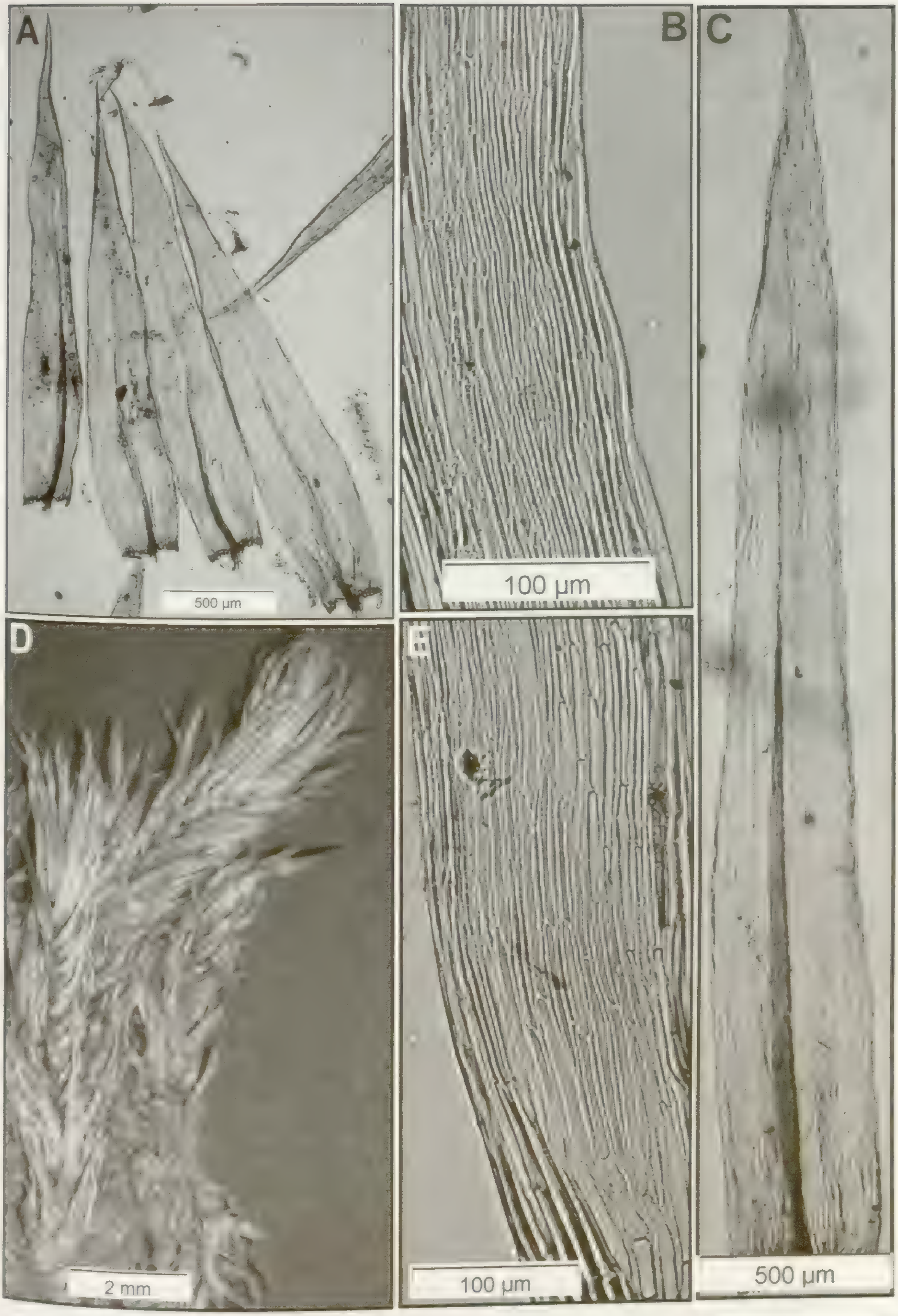

FIG. 3. *Daltonia lindigiana*. **A, C.** leaf outline; **B.** upper portion of leaf showing the linear cells; **D.** habit; **E.** lower portion of leaf.

narrower and of a different color than the generally quadrate, inner lamina cells. Additionally the leaves of *D. lindigiana* are usually straight and erect when dry in comparison to the generally more twisted leaves of *D. splachnoides*. The frequent presence of hyaline propagula on the lower lamina of *D. lindigiana* as well as the usually smooth to slightly roughened upper seta will also help in separating the two although at times the seta characteristic will be of little value when viewed alone as I have seen specimens of *D. lindigiana* with very scabrose upper setae as well as *D. splachnoides* plants with relatively smooth setae.

The plants that I have called *D. lindigiana* from the West Indies are generally markedly smaller than those from the mainland and the Galapagos Islands. The majority of smaller *D. lindigiana* collections were labeled as *D. stenophylla*.

Illustrations.—Fig. 3; Williams (1924, Pl. 7 fig. 1–11 as *D. stewartii*); Bartram (1931, Pl. 3 fig. 9, Pl. 4 fig. 10 as *D. stenophylla*); Sharp et al. (1994, fig. 577 as *D. stenophylla*); Arts (2005, fig. 15 (1–12) as *D. angustifolia*).

Habitat.—On the trunks of trees and shrubs, in humid forests to subpáramo, (500–)1000–3425 m.

Representative specimens examined: **COLOMBIA. Boyacá:** Andes Bogatenses, Boqueron prope Bogotá [4°55'N, 73°22'W], 2615 m, *Weir 193, 294, 336, 338* (NY). **Cundinamarca:** Bogotá, Boqueron [4°45'N, 73°54'W], 2700 m, *Lindig 2023* (BM, H-BR, L, NY). **Cundinamarca:** San Cayetano [5°18'N, 74°04'W], 2820 m, *Cleef 6592c* (U). **Nariño:** Pasto, Serrania del Morasurco, NE of the city of Pasto, 1°16'N, 77°14'W, 3425 m, *Ramirez 11200* (MO). **COSTA RICA. Cartago:** along Inter American Highway, bamboo brake about 8 km NW of summit of La Ascensión, 9°37'N, 83°47'W, 3200 m, *Crosby & Crosby 5832* (MO). **Puntarenas:** Reserva Biologica de Bosque Nubosa de Monte Verde, 10°15'N, 85°05'W, 1500–1600 m, *Crosby 9968* (MO). **San José:** La Palma area on regional road 220 beyond San Jerónimo, 10°03'N, 83°59'W, 1640 m, *Crosby & Crosby 5895* MO). **DOMINICAN REPUBLIC. La Vega:** 13.8 km S of Valle Nuevo, 44.7 km S of Constanza, vicinity of pyramids, [18°48'N, 70°41'W], 2277 m, *Steere 22722* (NY); The Pyramids, 40 km S of Constanza on road to San José de Ocoa, 18°45'N, 70°37'W, 2338 m, *Buck 14058* (NY). **ECUADOR. Galapagos:** Chatham Island, [0°55'S, 89°34'W], *Stewart 2782* (NY). **Napo:** summit of Cordillera de Huacamayos, on Baeza-Tena road 6–15 km S of Cosanga, in cloud forest [0°36'S, 77°52'W], 2165 m, *Steere 27653A* (NY). **Pichincha:** vicinity of Río Alambi, along road leading W from Nono toward Tandayapa. N slopes of Mt. Pichincha, 0°05'S, 78°30'W, 2340 m, *Crosby 10575* (MO). **HONDURAS. Ocotepeque:** Montaña del Candado, 13 km E of Nueva Ocotepeque & Cerro El Cocal, 12 km NE of Nueva Ocotepeque, 14°27'N, 89°04'W, 2090 m, *Allen 14424* (MO). **Olancho:** Sierra de Algalta, Montaña Babilonia. La Picucha & saddle between peaks, 13 km NNW of Catacamas, 14°57'N, 85°55'W, 2354 m, *Allen 12736* (MO). **MEXICO. Puebla:** between Acapulco and Cuetzalan [19°30'N, 98°00'W], 1500 m, *Sharp et al. 1077-a* (MO). **PANAMA. Bocas del Toro:** Cerro Colorado, 4.3 mi above Chami camp, 8°35'N, 81°45'W, 1700 m, *Allen 5249* (MO). **PERU. Amazonas:** Chachapoyas, Calla Calla, [6°13'S, 77°51'W], 3100 m, *Hegewald & Hegewald 6963b* (MO). **PUERTO RICO. Ponce:** Cordillera Central, Caribbean National Forest, Toro Negro Division, along Hwy 143 at km 21.7–22, 18°18'N, 65°47'W, 1400 m, *Buck 16218* (NY). **Rio Grande:** summit of El Yunque, Sierra de Loquillo, [18°19'N, 65°47'W, 1060 m], *Steere 6417* (FH, NY). **ST. VINCENT:** [13°08'N, 61°13'W], *Guilding s.n.* (NY).

4. Daltonia macrotheca Mitt., J. Linn. Soc., Bot. 12:402. 1869. (**Fig. 4**). PROTOLOGUE: ECUADOR: Andes Quitenses. Chimborazo in sylvis Cinchonae inter *Lepidopilum chloroneuron*, *Spruce s.n.* (NY!).

Daltonia tenuifolia Mitt. J. Linn. Soc., Bot. 12:402. 1869. PROTOLOGUE: ECUADOR: [Chimborazo] Andes Quitensis, Pallatanga (6000 ped.), *Spruce 561* (FH!, NY!), *syn. nov.*

Plants small to large, yellow-green, in small to large tufts. Stems orange-black, 5.0–55 mm high, branches infrequent. Leaves lax, ± flexuose dry or wet, ± constricted near bottom ⅓ of lamina, 1.75–2.25 mm long, linear-lanceolate to ovate-lanceolate, apex acuminate; margin narrowly revolute throughout, border 1–3 cells wide at above, 6–12 cells wide at base; costa ending ca. ¾ leaf length; median-upper cells rhomboidal, short linear to elongate hexagonal, basal cells short rectangular to short linear, ± bulging, thin-walled, ± light-dark orange colored across the insertion. Asexual propagula small (10–30 µm) to medium-sized (60–70 µm), hyaline, fusiform, occurring near leaf base. Setae smooth to slightly papillose in upper ½, red, 5–14 mm long; capsule dark brown, cylindric, 1.0–2.0 mm long; exothecial cells quadrate to ± irregular; exostome light orange, papillose, fenestrate in upper ½; endostome segments light orange, papillose. Spores not noticeably ornamented, 15–18 µm diam.

The plants represented by the type of *D. macrotheca* are quite distinctive in comparison to the "normal" expression of the species. Stems of the type measure as much as 55 mm in height while most other collections rarely exceed 1 cm in height. One can hardly find fault with Mitten describing both *D. macrotheca* and *D. tenuifolia* in the same publication as the size differences between the two types are quite striking but if my interpretation is correct such size variation occurs among several members of the genus (i.e., *D. jamesonii*, *D. lindigiana*, *D. ovalis*, *D. pulvinata*). I believe that the plants represented by the type of *D. macrotheca* are just an

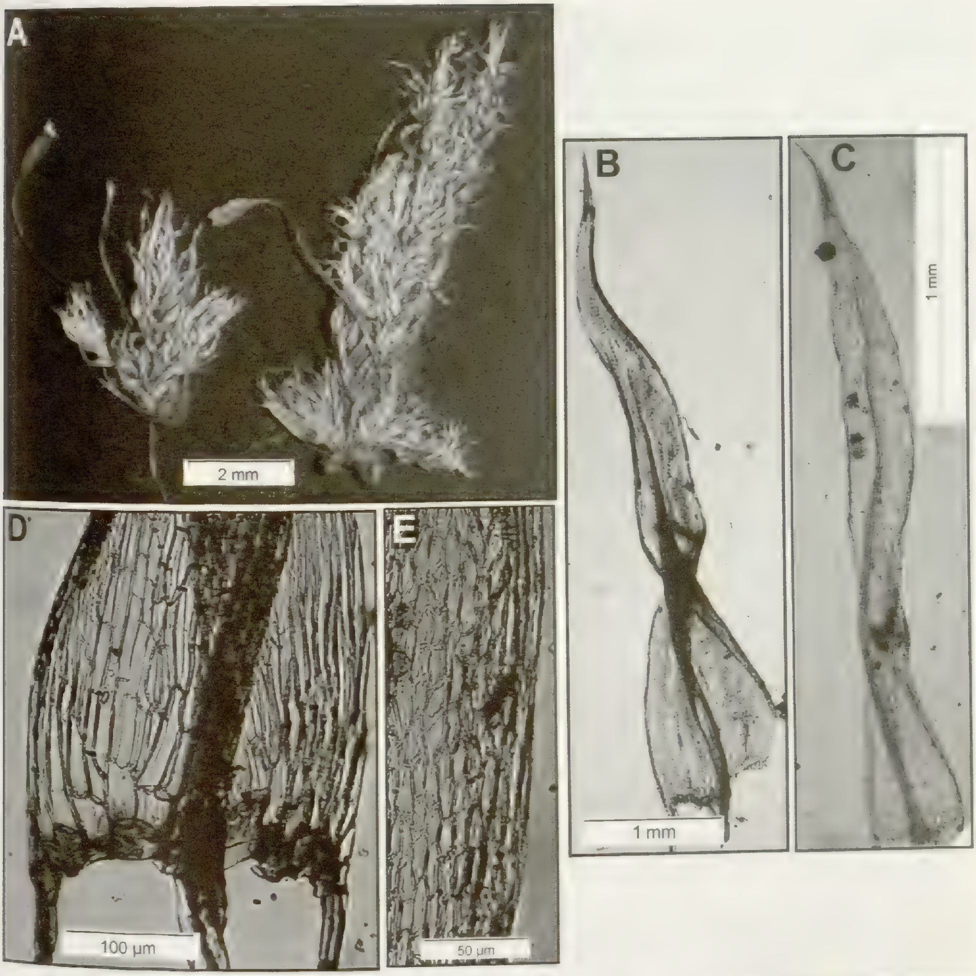

FIG. 4. *Daltonia macrotheca.* **A.** habit (notice the relatively large capsule which can aid in separation of small plants from *D. splachnoides*); **B–C.** leaf outlines showing the constriction in the basal portion of the leaf which is a characteristic of this species; **D.** basal portion of leaf showing the somewhat bulging basal cells; **E.** mid-laminal cells.

anomaly as I have seen no collections other than the type that comes close to reaching their height and I find it hard to believe that plants of such a stature would not have been extensively collected if it was the norm for the species. I have chosen to maintain the name *D. macrotheca* instead of *D. tenuifolia* because the type of *D. macrotheca* is in much better condition than the latter and it shows the morphological characteristics that diagnostic for the species very well. Even when small the plants of *D. macrotheca* have leaves that are somewhat constricted about ⅓ from the base. The lax, flexuose nature of the leaves generally allows the stem to be seen clearly which is uncharacteristic of the other species of the genus. The species most likely to be confused with *D. macrotheca* is *D. splachnoides*. Besides the previous mentioned characteristics these two can be separated by the relatively smooth seta of *D. macrotheca* versus the noticeably papillose upper seta of *D. splachnoides*. The capsule of *D. macrotheca* is also generally much larger than that of *D. splachnoides*. Another characteristic that is useful in separating the two is that *D. macrotheca* generally has an area of bulging cells in the inner basal area that is not present in *D. splachnoides*.

Illustrations.—Fig. 4; Bartram (1931, Pl. 3 fig. 6, Pl. 4 fig. 16 as *D. tenuifolia*); 1949, fig. 131 G–H as *D. tenuifolia*); Sharp et al. (1994, fig. 575 a–f as *D. tenuifolia*).

Habitat.—On tree trunks and twigs, 1300–2680 m.

Representative specimens examined: **BOLIVIA. Cochabamba:** Carrasco, El Limbo, camino antigua al Chapare, 17°08'S, 65°38'W, 2080 m, *Mogro & Altamirano 398* (MO). **COSTA RICA. Cartago:** Dos Amigos area, near 73 km marker on Inter American Highway, SE of El Empalme, 9°37'N, 83°50'W, 2680 m, *Crosby & Crosby 8581* (MO). **San José:** Cerro Daser area, 6 km along road that turns off W from national road 4, 5 km S of Asseri, 10 km SSE of San José, 9°50'N, 84°07'W, 2250 m, *Crosby & Crosby 8560* (MO). **ECUADOR. Pichincha:** along road 71 from Interamerican Highway toward Santo Domingo de los Colorados, 0°20'S, 78°40'W, 2600 m, *Crosby 10487* (MO). **HONDURAS. Comayagua:** from Agua Amarilla to San Jose del Los Planes, ca. 11–15 km E of Lake Yojoa, 14°47'N, 87°51'W, 1500 m, *Allen 13992* (MO). **MEXICO. Oaxaca:** on hwy 175, ca. 23 km N of Ixtlan de Juarez, [17°20'N, 96°29'W], 2100 m, *Norris &Taranto 16415* (MO). **PANAMA. Chiriqui:** ca. 5.4 km from El Hato Volcan on road to Las Lagunas, [8°46'N, 82°38'W], 1300 m, *Correa 1440B* (MO). **PERU. Cusco:** Aguas Calientes near Machu Picchu, [8°50'S, 74°41'W], 2100 m, *Hegewald & Hegewald 8724* (MO). **VENEZUELA.** Portuguesa: 15 km to the E of Chabasquen, 67 km NNE of Guanare, 9°27'N, 69°54'W, 1485 m, *Steyermark et al. 126799B* (MO).

5. Daltonia marginata Griff., Calcutta J. Nat. Hist. Misc. Arts Sci. India 3:270. 1842. (**Fig. 5**). PROTOLOGUE: INDIA: Khasia Hills, Mawflong, *Griffith 330* (H-BR!).

Daltonia longifolia Taylor, London J. Bot. 7:284. 1848. PROTOLOGUE: ECUADOR: Pichincha, on [Mt.] Pichincha near Quito, *Jameson s.n.* (FH!), *syn. nov*

Daltonia contorta Müll. Hal., Synopsis Muscorum Frondosorum omnium hucusque Cognitorum 2:660. 1851. PROTOLOGUE: Habitat insulam Javae, sine loco, *Blume s.n.* (?), *syn. nov.*

Daltonia flexifolia Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2:146. 1859. PROTOLOGUE: NEPAL: *Wallich s.n.* (NY!), *syn. nov.*

Daltonia scaberula Mitt., J. Proc. Linn. Soc., Bot., Suppl. 2:146. 1859. PROTOLOGUE: CEYLON: *Thwaites s.n.* (NY!).

Daltonia patula Mitt., J. Linn. Soc., Bot. 7:162. 1863, *illegitimate, later homynym. Daltonia mittenii* Kis, Proc. Third Meeting Bryologists Central & East Europe 220. 1984. PROTOLOGUE: Fernando Po [Isla Bioko, Equitorial Guinea], Peak Clarence, alt. 7,000 ft, with *Neckera pennata*, *Mann s.n.* (BM!, NY!), *syn. nov.*

Daltonia brasiliensis Mitt., J. Linn. Soc., Bot. 12:399. 1869. PROTOLOGUE: BRAZIL: Brasilia, Sierra de Piedada, porv. Minas Geraès. *Gardner 78* (H-SOL!, NY!), *syn. nov.*

Daltonia aristata Geh. & Hampe, Vidensk. Meddel. Dansk Naturh. For. Kjøben. ser. IV, 1:121. 1879. PROTOLOGUE: BRAZIL: Prope São Paulo, May–Aug 1879, *Puiggari s.n.* (FH!, H-BR!, L!), *syn. nov.* The collection at L contains a small amount of *D. splachnoides* as well.

Daltonia latimarginata Besch., Ann. Sci. Nat. Bot., VI, 10:277. 1881. PROTOLOGUE: LA RÉUNION: Ravine sèche, associé au *D. minor*, et plaine des Palmistes, G. de L'Isle; sommet de la rivière des Roches, *P. Lepervanche s.n.* (BM!), *syn. nov.*

Daltonia intermedia Renauld & Cardot, Bull. Soc. Bot. Belg. 33(2):127. 1894[1895], *illegitimate, later homynym; Daltonia cardotii* Bizot & Onr., Rev. Bryol. Lichénol. 42:851. 1976. PROTOLOGUE: MADAGASCAR: Grand Comore (Humblot), in jugo Ikongo, *Dr. Besson s.n.* (PC!), *syn. nov.*

Daltonia longicuspidata Müll. Hal., Bull. Herb. Boissier 5:201. 1897. PROTOLOGUE: GUATAMALA: Coban, Dec 1885, *d. v. Turckheim* (H-BR!) [published as *D. longo-cuspidata* an invalid, orthographic variant], *syn. nov.*

Daltonia dusenii Müll. Hal. ex Broth., Bot. Jahr. Syst. 24:259. 1897. PROTOLOGUE: [CAMEROON]: Mt. Kamerun, Bomana, ca. 1000 m, 19 Jul 1892, *Dusen 776* (H-BR!), *syn. nov.*

Daltonia latimarginata var. *madagassa* Renauld, Prodrome de la Flore Bryologique de Madagascar des Mascareignes et des Comores 292. 1898. PROTOLOGUE: MADAGASCAR: Ankeranadinika, 1400 m, *Dorr s.n* (PC!) *syn. nov.*

Daltonia dussii Broth. in Urb., Symb. Antill. 3:426. 1903. PROTOLOGUE: LESSER ANTILLES: Martinique, inter Ajoupa and Bouillon, ad ramulos arborum ramisima, Aug 1901, *Duss 345* (H-BR!).

Daltonia contorta var. *humilis* M. Fleisch., Die Musci der Flora von Buitenzorg 3:962. 1908. PROTOLOGUE: West-Java oberhalb Tjibeureum 2000 m, *Fleischer s.n.*; um Tjibodas auf Blättern 1500 m, *Fleischer s.n.*; bei Tjipannas in härten an Aesten 1000 m, *Fleischer s.n.*, (FH! – 3 syntypes on same sheet), *syn. nov.*

Daltonia latolimbata Broth., Biblioth. Bot. 87:129. 1916. PROTOLOGUE: BOLIVIA: Incacorral, alt. 2200 m, *Herzog 4950/a* (JE!), *syn. nov.* The isotype material at Jena contains two packets. The upper packet labeled *Herzog 4950* from (W) contains both *D. bilimbata* and *D. marginata*. The lower packet contains only *D. marginata*. Some of the plants differ only in that some leaves have elongate juxtacostal cells in the basal region. When taken into context with other taxa in the genus which exhibit cells of this nature to varying degrees, particularly *D. ovalis*, I don't believe it enough to warrant recognition at the species level, particularly when "normal" plants of *D. marginata* are present in the sample.

Daltonia euryloma P. de la Varde, Rev. Bryol. Lichén. 18:18. 1949. PROTOLOGUE: CAMEROON: Bambuto, alt. 2000 m, epiphyte sur brindiles, *M. Jacques-Félix 5434* (NY!, PC!), [packet also contains *D. splachnoides*], *syn. nov.*

Daltonia plicata P. de la Varde, Arvik. Bot., Andra Serien 3:181. 1955. PROTOLOGUE: Afrique orientale, [Mbarara]: Bujuku Valley, in the lower part of the ericaceous belt, 3150 m, *O. Hedberg 345e* (PC!), *syn. nov.*

Plants small to medium-sized, yellow to golden brown, small to medium tufts. Stems orange, 5–15(–30) mm

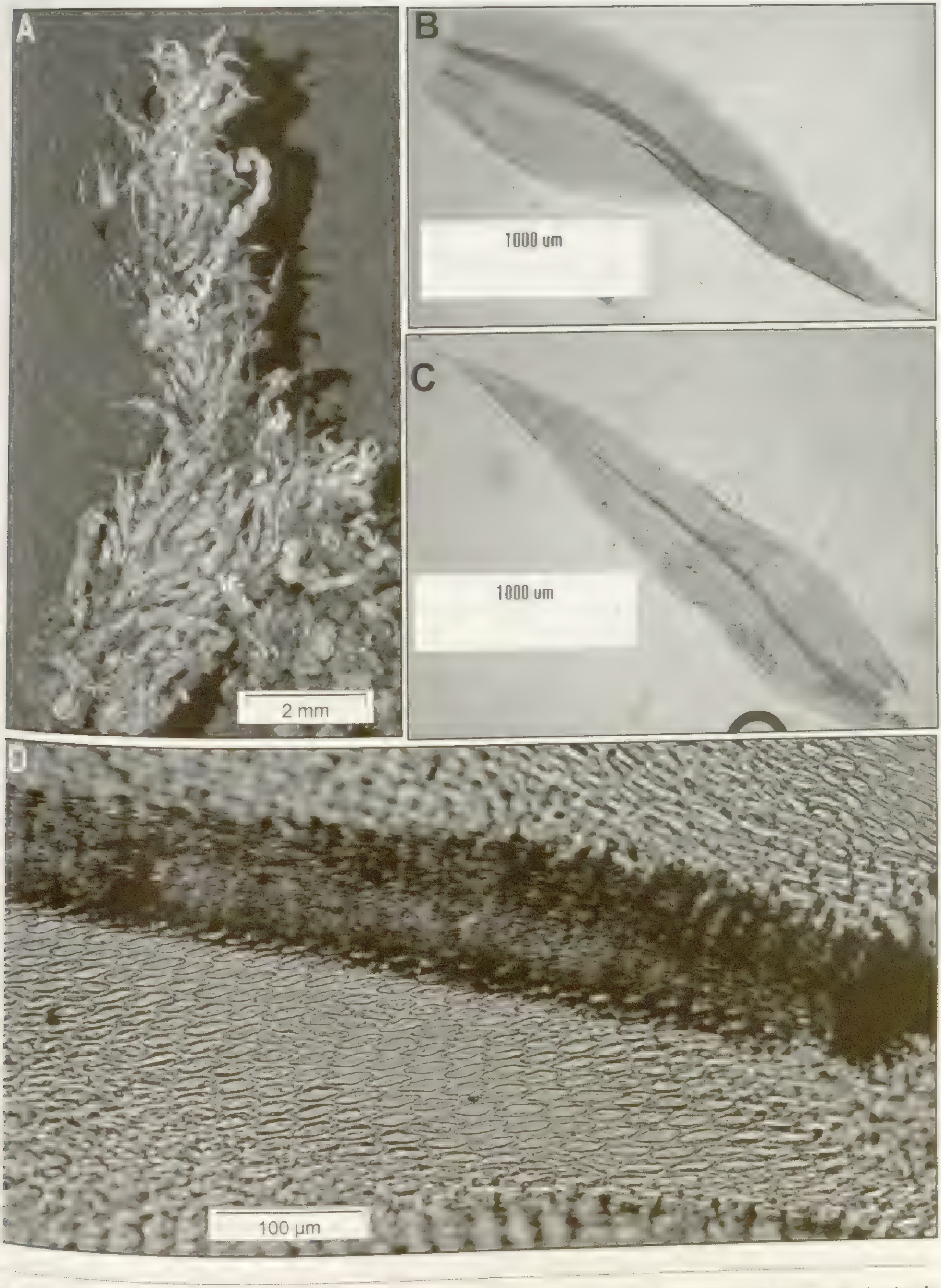

FIG. 5. *Daltonia marginata*. **A.** habit; **B–C.** leaf outlines (B. "*brasiliensis*" leaf morphology, C. "*aristata*" leaf morphology); **D.** laminal cells showing the characteristic oval shape which occur throughout the lamina with the exception of the very basal area of the leaf which can have somewhat rectangular to quadrate cells.

high, rarely branching. Leaves spirally contorted when dry, erect to erect-spreading, not much contorted when moist, 1.5–3.0 mm long, broadly-ovate lanceolate to oblong-ligulate to lanceolate, apex acute to acuminate; margins plane, border 1–2(–3) cells wide above, 6–12(–16) wide at base, plane; costa ending ca. ⅗–⅘ leaf length; median-upper cells lenticular, often in oblique rows, basal cells lenticular to short linear becoming more or less rectangular a few rows above the insertion, light-dark orange colored across the insertion. Asexual propagula infrequent, medium to large-sized (90–450 μm), hyaline or light orange, fusiform or rarely branched and with rhizoids forming (*Allen 12301*, MO), occurring on stem. Setae papillose in upper ½ or rarely to the base, reddish, 5–12 mm long; capsules reddish brown, ovoid to cylindric, 0.8–1.5 mm long; exothecial cells subquadrate to irregular; exostome yellow, papillose to spiculose; endostome segments yellow, papillose to spiculose. Spores faintly papillose, 111–8 μm diam.

Illustrations.—Fig. 5; Dozy & Molkenboer (1862, Tab. 155 fig. 1–46 as *D. contorta*); Brotherus (1925, fig. 592 A–E as *D. contorta*); Bartram (1931, Pl. 3 fig. 2, 3 as *D. braziliensis*, 4 as *D. aristata*, Pl. 4 fig. 16 as *D. latolimbata* (incorrectly labeled as fig. 14 in the plate explanations); Bartram (1933, fig. 137 a–f as *D. contorta*); Bartram (1939, Pl. 19 fig. 319 as *D. contorta*); Bartram (1949, fig. 131 D–F); Potier de la Varde (1957, fig. 3 1–7 from holotype *D. constricta*); Welch (1966, figs. 131–138); Tan & Robinson (1990, fig. 12 as *D. contorta*); Mohamed & Robinson (1991, figs. 30–36 as *D. contorta*); Sharp et al. (1994, fig. 574 a–f); Churchill & Linares (1995, fig. 56 g–m); Kis (1996, fig. 1 1–3 from holotype *D. latolimbata*); Buck (1998 Pl. 1 fig. 7–10); Gradstein et al. (2001, fig. 105 J–P); Buck (2003, fig. 83 A–F).

Habitat.—On twigs and tree trunks primarily although occasionally growing on bamboo or leaves, in humid and cloud forest, (350–)1000–3000(–4000) m.

Daltonia marginata is one of the most widespread and easiest species within the genus to identify. The contorted leaves when dry combined with the lenticular cells throughout the lamina (with the exception of the most basal area) are two characteristics which will separate it from the other species within the genus. The only species likely to be confused with *D. marginata* is *D. pulvinata* which also exhibits somewhat oval cells in the distal half of the lamina and has leaves which are contorted as well. The more horizontal arrangement of the leaves around the stem in *D. pulvinata* as well as the generally quadrate nature of the basal cells will aid in separation of the two which are frequently found growing together. The other species found quite often with *D. marginata* is the far ranging *D. splachnoides* which is easily identified from *D marginata* by its generally smaller size as well as having leaves that are not markedly contorted.

The leaf shape of *D. marginata* can be quite variable which has led to quite a number of extraneous names being associated with the species. When viewed in the extreme forms such as the type of *D. latolimbata* with its very broad ovate-lanceolate leaves and elongate juxtacostal cells versus the type of *D. marginata* which is on the opposite end of the size spectrum for the species and bears more or less small, narrow, lanceolate leaves one can certainly see how mistakes could have been made in assigning new names to a plant that exhibits such morphological plasticity when it comes to leaf size and shape. Regardless of the shape or size the two aforementioned characteristics, contorted leaves and lenticular cells throughout the lamina, remain consistent across the spectrum.

Representative specimens examined: **BELIZE. Toledo:** Columbia River Forest Reserve, Little Quartz ridge, along trail from HLS 500 to peak. 16°24'N, 89°06'W, 1045 m, *Allen 18958* (MO). **BOLIVIA. Antioquia:** Valdivia Municipio, carretera a Briceno, al lado de Quebrada El Oro, 7°07'S, 75°47'W, 1695 m, *Churchill et al. 18351* (MO). **Cochabamba:** Carrasco, Serrania Siberia. ca. 4 km oeste de El Churo, 17°48'40"S, 64°46'44"W, 2720 m, *Churchill et al. 22636* (MO). **La Paz:** Nor Yungas, 20 km SW of Yolosa junction on road to Unduavi, 16°18'S, 67°50'W, 2500 m. *Crosby 13592* (MO). **Potosi:** Inca Corral, [18°04'S, 65°50'W], 2200 m, *Herzog 4950* (L). **Santa Cruz:** Manuel M. Caballero 11 km este de Siberia, 1 km por San Mateo, 17°50'S, 64°41'W, 2540 m, *Churchill et al. 21884* (MO). Tarija: Arce, Municipio de Padcaya. Reserva Natural Alarachi, Zona Alarachi, Cerro Los Tejerinas, 22°11'S, 64°36'W, 2025 m, *Churchill et al. 23402* (MO). **BRAZIL. Minas Gerais:** Pocos de Caldas, Morro São Domingos, 21°48'S, 46°34'W, 1580 m, *Schäfer-Vervimp & Vervimp 14424* (BR, MO); Rio de Janeiro, [22°54'S, 43°14'W], *van Deventer s.n.* (L). **São Paulo:** Mun. Guapiara, Serra Paranapiacaba, Fazenda Intercales, slopes of Morro do Mirante, 24°16'S, 48°25'W, 900 m, *Vital & Buck 20467A* (NY). **CHILE. Arauco:** Hwy P-80-R, 3 km E of Antiquina, 38°02'S, 73°21'W, 350 m, *Ireland & Bellolio 33520* (MO). **COLOMBIA. Antioquia:** Caldas Municipio, Vereda La Corrala, cerca de Medellín, 6°17'N, 75°32'W, 2360 m, *Churchill et al. 15557* (MO). **Boyacá:** Nueva Granada, Tequendama, [05°44'N, 74°16'W], 2500 m, *Lindig s.n.* (L). **Cauca:** Municipio de Popayán, ca. 10–12 km from Popayán, Hacienda Cantaclaro de Mauricio Pinzon, 02°31'N, 76°34'W, 1800 m, *Churchill & Franco 16587-c* (NY). **Nariño:** Municipio Pasto,

Vereda Daza, 10–12 km de Pasto via a Buesaco, 1°15'N, 77°16'W, 2890 m, *Churchill et al. 16666* (MO). **Putamayo:** San Francisco, entre El Río Blanco and San Francisco, 1°10'N, 76°49'W, 2650 m, *Ramírez et al. 8528* (MO). **COSTA RICA. Alajuela:** grounds of Rancho Trebol, 10°30'N, 84°30'W, 1400 m, *Crosby 3796* (MO). **Cartago:** Madreselva area, near Río Macho, 2 km along road which turns NE from Inter American Highway 10 km SE of El Empalme, 9°42'N, 83°53'W, 2450 m, *Crosby & Crosby 5843* (MO). **Heredia:** Las Vueltas area, 18 km N of San Jose, 10°06'N, 84°03'W, 2100 m, *Crosby & Crosby 5996* (MO). **Puntarenas:** Las Cruces, 8°48'N, 83°01'W, 1200 m, *Gomez 25379* (MO). **San José:** La Palma area on regional road 220 beyond San Jerónimo, 10°03'N, 83°59'W, 1640 m, *Crosby & Crosby 5890* (MO, U). **CUBA. Granma:** Sierra Maestra near Pico Bayamesa, 20°03'N, 76°35'W, 1350 m, *Pócs 9066/DF* (EGR). **Santiago de Cuba:** La Gran Piedra, from base of peak near lodge to summit, 19°59'N, 75°35'W, 1100 m, *Buck 7647A* (NY). **DOMINICAN REPUBLIC. Barahona:** above Monteada Nueva, 17 km N of Cabral, then 24 km E to "El Gajo", 18°18'N, 71°16'W, 1310 m, *Buck 8165* (NY). **Independencia:** along the Carretera Internacional near the crest of the Sierra de Meiba range along Haitian border, 18°40'N, 71°30'W, 1850 m, *Norris et al. 6039* (NY). **La Vega:** vicinity of Constanza on road to Valle Nuevo, [18°52'N, 70°43'W], 1400 m, *Allard 16564* (NY). **Santiago:** Pico Diego de Ocampo, 19°35'N, 70°44'W, *Judd 1590* (NY). **ECUADOR. Azuay:** 21 km S of Sigsig on road to Gualaquiza, 3°06'S, 78°48'W, 2928 m, *Buck 39321A* (NY). **Galápagos:** Isla Santa Cruz, top of Cerro Maternidad, 0°32'S, 90°20'W, 675 m, *van der Werff 1778* (U). **Morona-Santiago:** along Gualaceo-Gral, L. Plaza Gutierrez ("Limón") Hwy, 25.8 km SE of bridge at entrance to Maylas Reserva Ecologia Natural, 23.6 km SE of shrine at crest of mountain, 3°00'S, 78°27'W, 2240 m, *Buck 39275* (NY). **Napo:** 8.9 km S of Cosanga, on road to Tena, 0°40'S, 77°51'W, 1800 m, *Churchill & Sastre-DeJesús 13626* (NY). **Pichincha:** W slope of Pasachoa, ca. 30 km SSE of Quito, 0°25'S, 78°28'W, 2900 m, *Buck 10120* (NY). **Tungurahua:** 14–19 km W of Baños along road 78, slopes above left bank of Río Pastaza, 1°25'S, 78°25'W, 1800 m, *Crosby 10621* (MO). **Zamora-Chinchipe:** Cordillera de Sabanilla, ca. 44 km S of Vilcabomba on road to Zumba (Hwy 39), 4°30'S, 79°08'W, 2800 m, *Buck 39508B* (NY). **HAITI. Departement de l'Ouest:** vicinity of Furcy, 15°25'N, 72°19'W, 1300 m, *Leonard 4620b* (NY). **Sud'est:** Massif de la Selle, 8 km N of Sequin on road to Kenscoff, 15°21'N, 72°15'W, 1900 m, *Buck 9454* (NY). **HONDURAS. Comayagua:** Cordillera de Montecillos Montana de San Jaunillo, trail between Cerro San Jaunillo & La Danta, 14°30'N, 87°52'W, 2020 m, *Allen 11031* (MO). **Cortes:** Cusuco National Park, along Río Cusuco from Park Hdq. to Cascada del Río Cusuco ca. 22 km W of San Pedro Sula & 16 km S of Cuyamel, 15°30'N, 88°13'W, 1570 m, *Allen 14364* (MO). **Lempira:** Montaña de Celaque, quebrada along stream below Camp Don Tomás, 14°34'N, 88°39'W, 2040 m, *Allen 11251* (MO). **Ocotepeque:** Montaña del Candado, 13 km E of Nueva Ocotepeque & Cerro El Cocal, 12 km NE of Nueva Ocotepeque, 14°27'N, 89°04'W, 2090 m, *Allen 14488A* (MO). **Olancho:** La Muralla Biological Reserve, 8 km NNW of La Union, 15°05'N, 86°44'W, 2354 m, *Allen 12851* (MO). **JAMAICA. Portland:** just N of Hardwar Gap, [18°00'N, 76°30'W], 1230 m, *Griffin 1104* (MO, NY). **MEXICO. Hildago:** Honey Station, [20°30'N, 99°00'W], *Pringle 10487* (L, MO, NY). **Oaxaca:** along road N of Llano de Las Flores N of Oaxaca [16°54'N, 96°00'W], 2250 m, *Iwatsuki & Sharp 5341* (MO). **Puebla:** between Acapulco and Cuetzalan, [19°30'N, 98°00'W], 1500 m, *Sharp et al. 1097-b* (MO). **Veracruz:** Jalapa Municipio, 17 km NE of Jalapa along Mex Rte 140, 19°32'N, 96°55'W, 2150 m, *Reese 4590-b* (MO). **PANAMA. Bocas del Toro:** Cerro Colorado, 4.3 mi above Chami camp, 8°35'N, 81°45'W, 1700 m, *Allen 5249A* (MO). **Coclé:** N of El Valle de Antón, base of Cerro Pilón, 8°35'N, 80°10'W, 1000 m, *Crosby 4392B* (MO). **Veraguas:** 10.4 km along road leading NW from Escuela Agricola "Alto de Piedra," 5.4 km NW of Santa Fé, 8°30'N, 81°05'W, 350 m, *Crosby 10150A* (MO). **PERU. Ayacucho:** La Mar, 3 km from Ayna in the direction of Ayacucho, 12°39'S, 73°55'W, 1500 m, *Hegewald & Hegewald 9044* (MO). **Cusco:** Suchubamba, just S of southern border of Manu Park on road 100, 3000 m, *Majestyk 4952* (pers. coll.). **Huanuco:** Aguas Calientes near Machu Picchu, 8°50'S, 74°41'W, 2100 m, *Hegewald & Hegewald 8790* (MO). **Pasco:** Oxapampa, Rio Yamaquizu valley 16 km from turn off main road, 10°37'S, 75°22'W, 2550 m, *Smith C-25* (MO). **PUERTO RICO. Jayuya:** along E of Jayuya, km 30 on road to Ciales, 18°17'N, 66°32'W, *Steere 6081* (NY). **Ponce:** Cordillera Central, Caribbean National Forest, Toro Negro Division, along Hwy 143 at km 20, 18°18'N, 65°47'W, 1500 m, *Buck 15999* (NY). **VENEZUELA. Aragua:** along highway in the vicinity of Colonia Tovar, 10°25'N, 67°17'W, 1800 m, *Pursell 9294* (MO). **Portuguesa:** 15 km to the E of Chabasquen, 67 km NNE of Guanare, 9°27'N, 69°54'W, 1485 m, *Steyermark et al. 126799B* (MO).

6. **Daltonia ovalis** Taylor, London J. Bot. 5:66. 1846. (**Fig. 6**). PROTOLOGUE: ECUADOR: on trunks of trees, on Cayambe, about 14,000 ft, 20 Oct 1827, *Jameson s.n.* (HOLOTYPE: FH!; ISOTYPES: E!, NY!).

Daltonia cucullata Hampe, Linnaea 32:151. 1863. PROTOLOGUE: COLOMBIA: Bogotá, Los Laches, 2800 m, Sep [1859], *Lindig 2023b* (BM!). The type of *D. cucullata* resembles the type of *D. ovalis* closely. Both plants have leaves on the smaller side as well as having the elongate juxtacostal cells in very thin bands and in some leaves these elongate cells are virtually absent.

Daltonia trachyodonta Mitt., J. Linn. Soc., Bot. 12:400. 1869. PROTOLOGUE: ECUADOR: Andes Quitensis, Cayambe, una cum *D. ovali*, *Jameson s.n.* (NY!), *syn. nov.*

Daltonia androgyna Geh. & Hampe, Flora 64:405. 1881. PROTOLOGUE: [BRAZIL]: Apiahy, Sep 1879, *Puiggari 985b* (BM!, H-BR!, NY!), *syn. nov.* [The type at BM contains three small groups of plants, the two on the left are *D. ovalis*, the one at the right is *D. pulvinata*. The collection at H-BR contains only two plants both of which are *D. marginata*. The collections made by Puiggari (#892) a month earlier in the same location are plants of *D. pulvinata*]. Another collection at L (likely isotype) contains four small groups of plants all of which are *D. ovalis*.

Daltonia valdiviae Herzog, Hedwigia 64:15. 1923. PROTOLOGUE: CHILE: An Baumrinde im Stadtpark von Valdivia, Dec 1911, *Herzog 5268* (FH!, JE!). Plants are on the small size but clearly represent *D. ovalis*. Hyaline gemmae are present on the leaf bases.

Daltonia rufescens Broth., Bernice P. Bishop Mus. Bull. 40:24. 1927. PROTOLOGUE: HAWAII: West Maui, mountain ridges, on trunks, elev. 1500 m, *D. D. Baldwin 148* (H-BR!, FH!), *syn. nov.*

Daltonia brevinervis E.B. Bartram, Bull. Torrey Bot. Club 58:37. 1931. PROTOLOGUE: COLOMBIA: Paramo El Boqueron near Bogotá, 3300 m, *Troll 2176* (JE!), *syn. nov.*

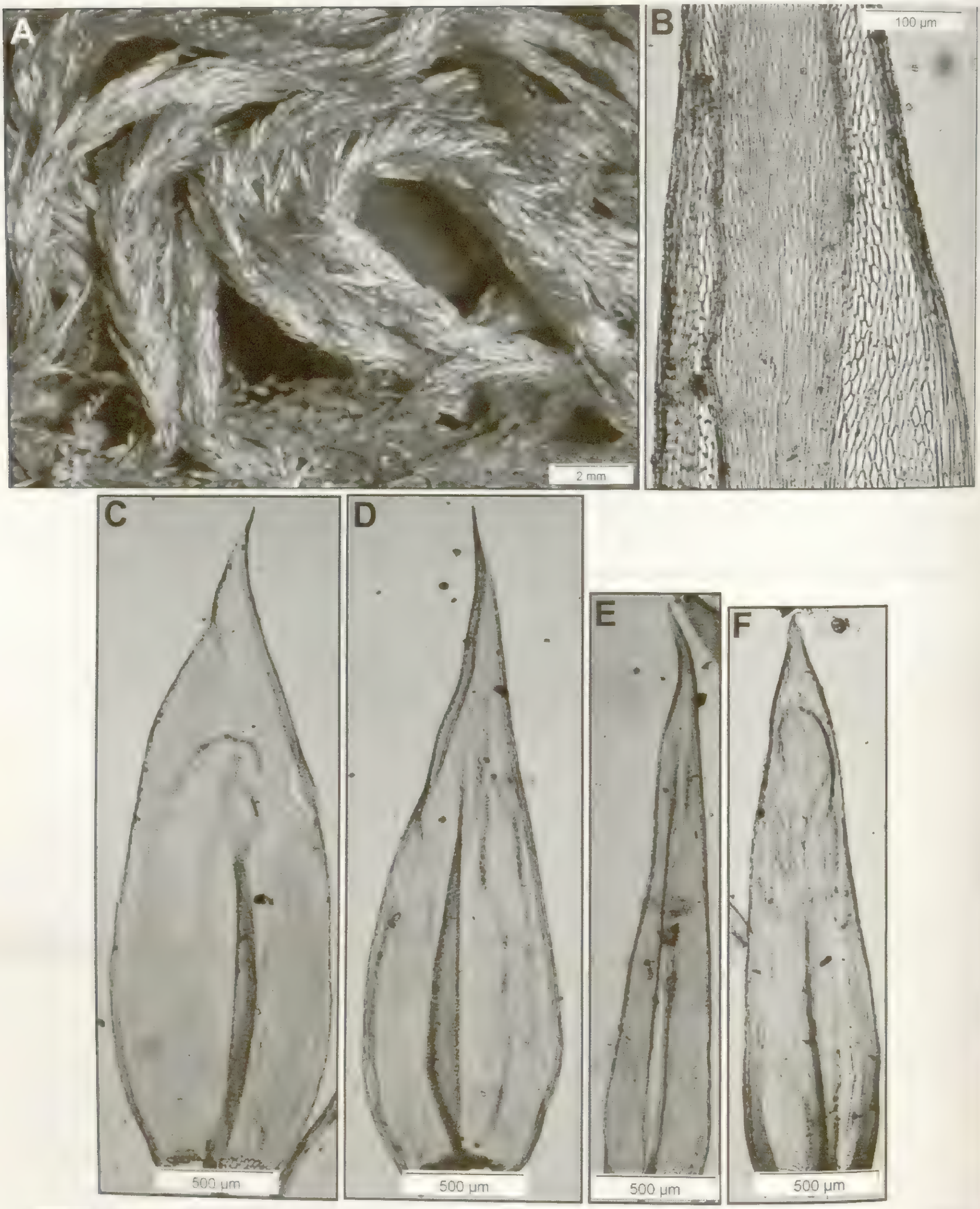

Fig. 6. ***Daltonia ovalis*. A. habit; B. upper portion of lamina showing the broad band of elongated juxtacostal cells characteristic of the "*brevinervis*" and "*fenestrellata*" plants; C–F. from left to right "*gomezii*", "typical" *ovalis*, "*brevinervis*", "*fenestrellata*."**

Daltonia trachydontia Mitt. ex E.B. Bartram, Bull. Torrey Bot. Club 58:43. 1931, *nom illeg., orthographic variant.*

Daltonia gomezii Crosby, Brenesia 4:10. 1974. Protologue: COSTA RICA. Cartago: NW of La Ascensión, *Crosby & Crosby 6130* (MO!) syn. nov.

Daltonia fenestrellata D.G. Griffin, Brittonia 32:214. 1980. Protologue: COLOMBIA. Meta: Cerro Nevado de Sumapaz. Quebrada El Buque, 3350 m, *Cleef 7820* (U!).

Plants small to medium-sized, yellow-green to golden brown, in small to rather large tufts. Stems black, 10–50 mm high, branching irregularly. Leaves laxly erect-imbricate or moderately spiraling (in smaller plants), apex ± curved to downward pointing when dry, erect to erect-spreading when moist, (1–)1.5–3 mm long, ovate-lanceolate to ligulate, cuspidate to long attenuate; margins narrowly revolute throughout, borders ± confluent at apex or ending subpercurrently, 0–2 cells wide above, 6–14 cells wide at base; costa ending ca. ½–¾ the leaf length; upper cells short-rhomboidal, firm-walled, median cells short rectangular-short linear/rhombic, basal cells short-rectangular to ± quadrate, orange across the insertion. Asexual propagula small (10–30 µm), orange-red, or larger (70–200 µm), hyaline propagula present as well, ellipsoid to fusiform or rarely muriform, occurring over lamina. Setae smooth to slightly roughened in upper portion, red, 8–13 mm long; capsules erect, brown to ± maroon, ovoid-cylindric, 1.0–1.5 mm long; exothecial cells subquadrate to hexagonal, firm-walled; exostome teeth orange at base becoming yellow above, densely spiculose throughout; endostome segments yellow, densely spiculose throughout. Spores finely papillose, 14–24 µm diam.

Illustrations.—Fig. 6; Brotherus (1927, Pl. 6 fig. 20 from holotype *D. rufescens*); Bartram (1931, Pl. 3 fig. 7 as *D. brevinervis*, Pl. 4 fig. 18); Potier de la Varde (1955, fig. 28 A–K from holotype *D. plicata*); Matteri (1975, Lam. II figs. 1–9 as *D. trachyodonta*); Griffin (1980, figs. 1–8 as *D. fenestrellata*).

Habitat.—On twigs of trees and shrubs, rarely on bamboo nodes or rocks, occurring in páramos and cloud forests, at (1640–)3100–4300 m.

The variability in overall stem size, leaf shape, border width and extent and location of the elongate juxtacostal cells has helped to create confusion in this species. The only other *Daltonia* species in the Americas which exhibit at times, abundant, elongate juxtacostal cells are *D. lindigiana* and *D. marginata*.

Depauperate populations of *D. ovalis*, which sometimes consists of leaves with only a narrow band of elongate juxtacostal cells might be mistaken for *D. splachnoides*. The presence in *D. splachnoides* of sporophytes with markedly scabrose setae and relatively small capsules in comparison to relatively smooth setae and larger capsules of *D. ovalis* will help in distinguishing the two taxa. Larger plants of *D. splachnoides* are generally separable from *D. ovalis* by the consistently acute, plane leaf apex of *D. splachnoides* versus the subulate, cuspidate to attenuate apex of *D. ovalis*.

The more robust plants of *D. pulvinata* at times exhibit a very close similarity in leaf morphology although plants of *D. ovalis* generally have a more prominent attenuation at the leaf apex. The two can usually be separated by the frequent presence of larger, hyaline gemmae in *D. pulvinata* although I have seen similar gemmae in a few collections of *D. ovalis*. *Daltonia pulvinata* also generally has some plants with leaves horizontally spiraling about the stem while the leaves of *D. ovalis* are consistently erect.

The growth form represented by the type collections of *D. brevinervis* and *D. fenestrellata* is markedly different from "normal" *D. ovalis* plants. These plants have smaller leaves (1–1.5 mm long) that are narrowly ovate to ligulate-lanceolate with a generally downward curved, cuspidate apex. Some collections have this atypical form growing alongside "normal" *D. ovalis* and in some cases plants exhibit both types of leaves on the same stem. Collections by *Churchill et al. 22772* (MO), *van der Werff & Gudiño 11457* (MO) and *Cleef 7817* (U) contain plants that exhibit the wide array of variation in this species. A collection from Costa Rica (*Arts CR 13/33* (BR)) is an excellent specimen for showing the extreme variation in size of the plants with the larger plants situated directly above the smaller ones on the same grass culm.

Characteristics that remain fairly stable are the golden brown color of the plants, the dark-orange cells across the insertion, the small orange-red propagula occurring over the lamina, elongate juxtacostal cells (oftentimes extending outwardly beyond the costa apex or at times fairly indistinctive (only 1–2 rows adjacent to the costa)), short, rectangular or quadrate arranged basal-mid laminal cells and a generally smooth or very lightly papillose seta. Most collections examined where taken from 3000 m or higher elevations.

Representative specimens examined: **BOLIVIA. Cochabamba:** Chapare, 80 km de Villa Tunari, between Locotal-Coroni, carretera nuevo Cochabamba-Santa Cruz, 17°12'S, 65°58'W, 2600 m, *Churchill 22728* (MO). **La Paz:** Franz Tamayo, Area Natural de Manejo Integrado Apolobamba, 14°41'03"S, 69°05'35"W, 4150 m, *Fuentes et al. 8311* (MO); Murillo, Mina San Luis, carretera de Nor Yungas, 16°18'57"S, 67°56'W, 3700 m, *Churchill et al. 22772* (MO). **Santa Cruz:** Manuel M. Caballero, Serrania de Siberia, small lagoon E of Siberia, 17°50'S, 64°45'W, 2880 m, *Churchill et al. 22029* (MO). **CHILE:** Valdivia, An Baumrinde im Stadtpark von Valdivia, Dec 1911, *Herzog 5268* (FH, JE).

COLOMBIA. Boyacá: Municipio Chita, carretera Chita-Socha subiendo el Cardón, [6°11'N, 72°29'W], 3400 m, *Escobar A. & Santa 509* (NY). **Caldas:** Villamaria Municipio, cerca km 214 carretera que conduce el Nevado del Ruiz, 4°55'N, 75°21'W, 3575 m, *Churchill & Betancur 17923* (MO). **Cauca:** Volcán Purace, Cabeceras Río Vinagre, [2°19'N, 76°24'W], ca. 3800 m, *Cleef & Fernández P. 640* (U). **Cundinamarca:** an der Rinde von Vorpostenbaumchen, Páramo El Boqueron near Bogotá, [5°20'N, 73°42'W], 3300 m, *Troll 2176* (JE, S); Páramo Cruz Verde [4°34'N, 74°02'W, 3300 m, *Onraedt 78.A.9888* (BR). **Meta:** Cerro Nevado del Sumapaz, Quebrada El Buque, [3°56'N, 74°07'W], 3350 m, *Cleef 7820* (U). **Nariño:** Pasto Municipio, Volcán Galeras, in páramo, 1°12'N, 77°20'W, 3900 m, *Churchill & Rengifo M. 17476* (MO). **Quindío:** Cerca de La Linea, between Armenia and Ibague, 4°28'N, 75°33'W, 3140 m, *Churchill 17197* (MO). **Risaralda:** Municipio de Santa Rosa de Cabal, cerca Hda. La Sierra, 4°49'N, 75°29.5'W, 3700 m, *Wolf 9* (U). **Santander:** Municipio Cerrito, carretera Presidente-Cerrito, Páramo del Almorzadero, [6°51'N, 72°42'W], 3750 m, *Escobar A. & Santa 290* (NY). **COSTA RICA. Alajuela:** vicinity of Crater of Volcán Póas, 32 km NW of N of city center of San José, 10°11'N, 84°14'W, 2500 m, *Crosby & Crosby 5896* (MO). **Cartago:** along Inter American Highway, bamboo brake about 8 km NW of summit of La Ascensión, 9°37'N, 83°47'W, *Crosby & Crosby 6130* (MO). **Heredia:** Las Vueltas area, 18 km N of San José, 10°06'N, 84°03'W, 2100 m, *Crosby & Crosby 5996* (MO). **San José:** Parque Nacional Tapanti, Macizo de la Muerta, Reserva Forestal Los Santos, summit of Cerro de la Muerta, W of Ruta 2 between Km 89 and 90, *Chusquea*-shrub páramo, 9°33'17"N, 83°45'24"W, 3500 m, *Buck 44214* (NY). **ECUADOR. Azuay:** 24 km S of Sigsig on road to Gualaquiza, 3°07'S, 78°49'W, 3265 m, *Buck 39330* (NY). **Carchi:** along road Tulcan-Maldonado, W of Tufino, 0°45'N, 77°55'W, 3730 m, *Buck 10217* (NY). **Cotopaxi:** Volcán Cotopaxi, NW slope, road from Panamerican Highway to Parque Nacional Cotopaxi, [0°41'S, 78°26'W], 3500 m, *Frahm & Gradstein 14* (U). **Imbabura:** Cordillera Oriental, road up N slope of Volcán de Cayambe, 0°07'N, 78°00'W, 3877 m, *Steere 26867* (NY). **Loja:** Pass on the road Loja-Zamora, [4°0'S, 79°13'W], 2900 m, *van der Werff 9454* (MO). **Napo:** Cerro Sumaco, [0°35'S, 78°38'W], 3750 m, *Madison 6938* (U). **Pichincha:** Cordillera Oriental along Quito-Baeza highway, just W of pass, [1°15'S, 78°12'W], 3800 m, *Steere & Balslev 25705* (NY). **Zamora-Chinchipe:** Cordillera de Sabanilla, ca. 44 km S of Vilcabomba on road to Zumba (Hwy 39), 4°30'S, 79°08'W, 2800 m, *Buck 39508B* (NY). **HONDURAS. Lempira:** Montaña de Celaque, Río Naranjo, ca. 10 km SW of Gracias, small peak SE of Camp Don Tomás, 14°32'N, 88°39'W, 2100–2370 m, *Allen 12008A* (MO). **MEXICO. Hildago:** Honey Station, [20°30'N, 99°00'W], *Pringle 10487* (L, MO, NY). **PANAMA. Chiriquí:** along road to summit of Volcán Baru, 8°27'N, 82°18'W, 1800–3400 m, *Allen 9160A* (MO). **PERU. Amazonas:** Chachapoyas, Calla Calla, [6°13'S, 77°51'W], 3100 m, *Hegewald & Hegewald 6963* (MO). **Ayacucho:** Huanta, between Tambo and Ayna, [12°47'S, 73°58'W], 3825 m, *Hegewald & Hegewald 9105* (MO). **Junín:** Huancayo, 56 km from Huancayo in direction of Parihuanca, 14 km from Chilifruta, [11°35'S, 74°35'W], 3650 m, *Hegewald & Hegewald 9271* (MO). **VENEZUELA. Aragua:** along highway in the vicinity of Colonia Tovar, [10°25'N, 67°17'W, 2000 m], *Pursell 9294* (MO). **Mérida:** Rangel, Sierra de Santo Domingo, [8°54'N, 71°00'W], 3500 m, *Griffin 1236* (MO).

7. Daltonia pulvinata Mitt., J. Linn. Soc., Bot. 12:398. 1869. (**Fig. 7**). PROTOLOGUE: COLOMBIA: Andes Bogotenses, prope Bogatá, *Weir* (HOLOTYPE: NY!).

Daltonia revoluta Broth., Philippine J. Sci. 5:156. 1910. PROTOLOGUE: PHILIPPINES: Luzon, Province of Benguet, Mount Pulog, *For. Bur. 16405 Curran, Merritt & Aschokke* (FH!, H-BR!).

Daltonia mildbraedii Broth., Wissenschaftliche Ergebnisse der Deutschen Zentral Afrika-Expedition 1907–1908, Botanik 2:164. 1910. PROTOLOGUE: Rugege-Wald: An Asten spärlich, ca. 1200 m (Sep 1907), *J. Mildbraed 861* (H-BR!), [type packet has label information that appears to have elev. as 1900 m and a collection date of Aug 1907] *syn. nov.*

Daltonia pellucida Herzog, Biblioth. Bot. 87:128. 1916. PROTOLOGUE: BOLIVIA: Auf Baumästen im Nebelwald über Comarapa, ca. 2600 m, *Herzog 4214, 4281, 4294* (JE!), *syn. nov.*

Daltonia constricta P. de la Varde, Rev. Bryol. Lichénol. 26:4. 1957. PROTOLOGUE: MOZAMBIQUE: Gorongosa mountain near Gogogo peak, 5800 ft, 6 Jul 1955, *E. Schelpe 5575a* (BM!, PC!), *syn. nov.*

Daltonia onraedtii Bizot, Rev. Bryol. Lichénol. 40:126. 1974. PROTOLOGUE: LA RÉUNION. Plaine des Cafres, aux sources Reilhac, sur un arbre isolé, *M. Onraedt 147* (PC!).

Plants small to medium-sized, yellow-olive green, in small to rather large tufts. Stems erect, orange to red, 3–15 mm high, rarely branching. Leaves markedly flexuose when dry, ± perpendicular and loosely arranged around stem, 1.0–2.5 mm long, oblong-lanceolate to oblong-ligulate, apex acute to acuminate, ± slightly falcate when wet; margins narrowly revolute on one or both sides, borders confluent at apex, 1–2 cells wide above, 8–16 cells wide at base; costa ending ⅗–¾ the leaf length; upper cells short rhomboidal to linear to lenticular, mid laminal cells short rectangular to ± pentagonal/hexagonal or lenticular, basal cells short-rectangular to ± bulging hexagonal, ± quadrate. Asexual propagula medium-sized (60–75 µm) to large (125 µm), often numerous, hyaline (sometimes becoming darker when larger), fusiform, usually occurring in groups at the confluence of the leaf and stem. Setae papillose or ± smooth in upper half, orange-red, 4–11 mm long; capsules erect, olive-green to brown or ± bronze, ± cylindric, 1.0–2.0 mm long; exothecial cells quadrate to pentagonal/hexagonal or irregular, firm-walled; exostome pale yellow, papillose; endostome segments pale yellow, papillose. Spores relatively smooth to lightly papillose, 13–19 µm diam.

Illustrations.—Fig. 7; Bartram (1931, Plate 3 fig. 1, Plate 4 fig. 12 as *D. pellucida*); Sharp et al. (1994, fig. 573 a–e).

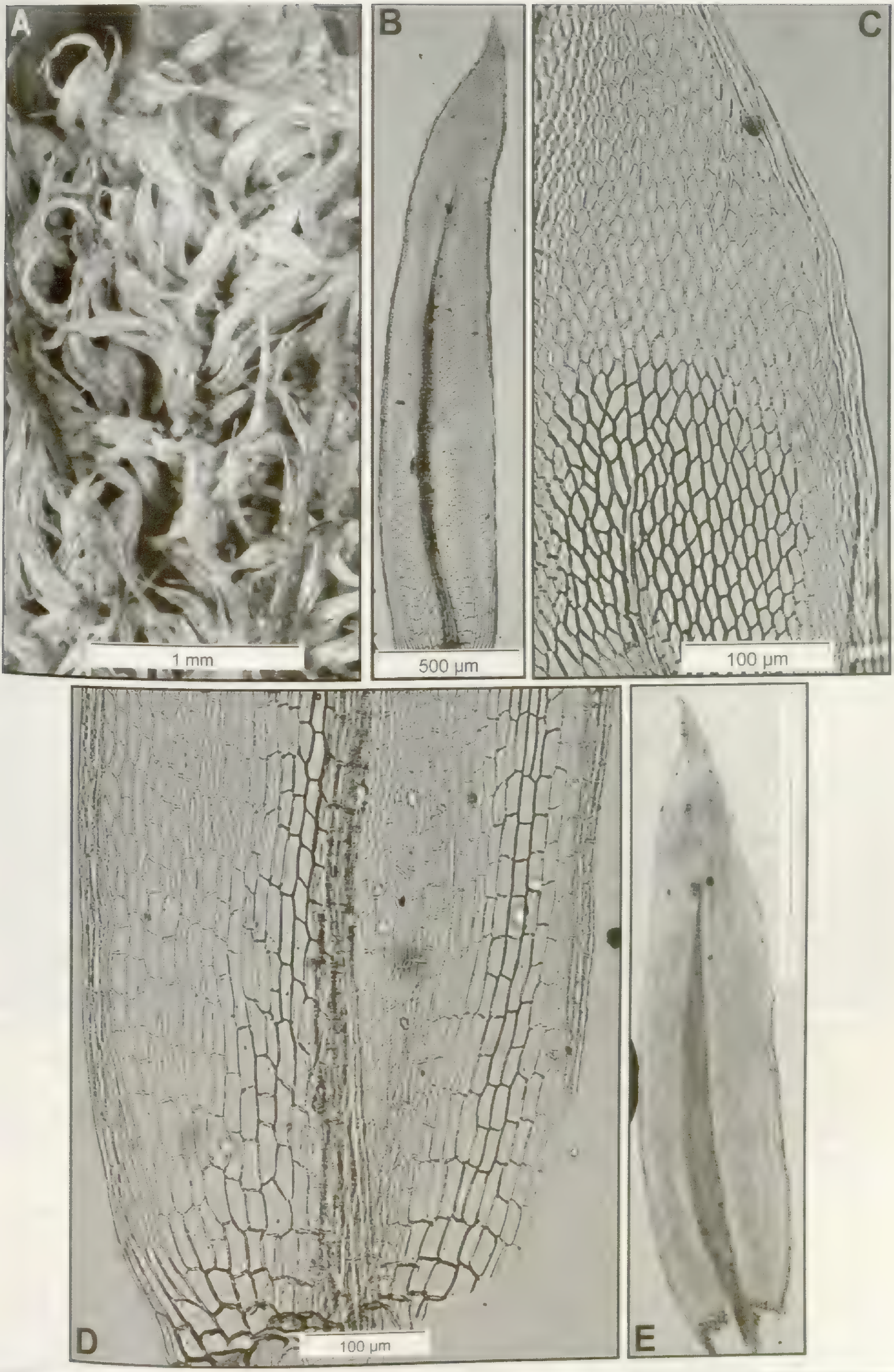

FIG. 7. *Daltonia pulvinata*. **A.** habit; **B.**, **E.** leaf outlines; **C.** mid to upper leaf cells; **D.** basal cells.

Habitat.—On tree trunks and branches, (700–)1200–3800(–4200) m.

Daltonia pulvinata is generally very easy to recognize. Most collections have some plants with the horizontally, spiraling leaves around the stem that are not much evident in other members of the genus. At times plants of *D. jamesonii* have leaves somewhat spiraling near the branch apex but in that species the leaves have cells that are quadrate throughout most of the lamina whereas the cells of *D. pulvinata* are somewhat quadrate only in the bottom ⅓ of the lamina and predominately lenticular in the upper ⅔ of the lamina. Clusters of hyaline gemmae are frequently found near the insertion of leaves in the bottom half of the plant.

From the material I have examined it is not uncommon for *D. pulvinata* to be growing with *D. ovalis* and *D. splachnoides* and to a lesser extent *D. marginata*.

Representative specimens examined: **BELIZE. Toledo:** Columbia River Forest Reserve, limestone sink between Union camp and Camp 1, 16°22'N, 89°07'W, 700 m, *Allen 18677* (MO). **BOLIVIA. Cochabamba:** Chapare, Canton Paracti, Cordillera El Ronco, carretera antigua Chapare, 17°14'S, 65°42'W, 3800 m, *Churchill 20579-A* (MO). **La Paz:** Inquisivi, along the Arco Pongo trail between Japo and Cargadero, SW slope of Cerro Ventanani ca. 2 km N of Japo and 28 km NE of Inquisivi, 16°45'S, 66°56'W, 3800–3830 m, *Lewis 87-747* (MO). **BRAZIL. Espirito Santo:** Mun. Iuna, Parque Nacional do Caparaó, along trail from Terreirão to the summit of Pico da Bandeira, 20°25'S, 41°43'W, 2620 m, *Vital & Buck 11791* (NY). **Minas Gerais/Rio de Janeiro:** Serra do Itatiaia, [22°22'S, 44°42'W, 2000 m], *Dusen s.n.* (NY). **São Paulo:** Serra de Mantiqueira, Campos do Jordão, Pico do Itapeva, [22°44'S, 45°35'W], 2020 m, *Schäfer-Verwimp & Verwimp 6925* (MO). **COLOMBIA. Antioquia:** Municipio Medellín, Abajo de Boqueron, ca. 25 km NE of Medellín, 6°20'N, 75°10'W, 2500 m, *Churchill et al. 13948-B* (MO). **Boyacá:** El Cocuy Municipio, carretera El Cocuy subiendo a Chita, 6°02'N, 75°08'W, 3750 m, *Escobar 434* (MO). **Caldas:** Villamaria Municipio, cerca km 214 carretera que conduce el Nevado del Ruiz, 4°55'N, 75°21'W, 3575 m, *Churchill & Betancur 17923* (MO). **Nariño:** Municipio Pasta, bosque de la granja de Botana, 1°10'N, 77°15'W, 3000–3200 m, *Ramírez P. 3136* (MO). **Puntarenas:** Reserva Biológica de Bosque Nuboso de Monteverde, 10°15'N, 85°05'W, 1500–1600 m, *Crosby 9968*(MO). **COSTA RICA. Cartago:** just SE of summit of Cerro de la Muerte ridge, 45.7 km SE of El Empalme (3.2 km W of W entrance to Villa Milla), 8°36'N, 83°46'W, 3050 m, *Crosby 13134A* (MO). **Puntarenas:** Coto Brus Canton, 8°46'N, 83°03'W, 1100–1400 m, *Dauphin 1981* (MO). **ECUADOR. Cotopaxi:** N slopes of Mt. Cotopaxi, 0°40'S, 78°25'W, 3500 m, *Crosby 10716* (MO). **Pichincha:** Just W of NASA tracking station on lower, western slope of Loma Ruminahui Central, 0°37'S, 78°34'W, 3450 m, *Crosby 10602* (MO). **HONDURAS. Comayagua:** from Agua Amarilla to San José del Los Planes, ca. 11–15 km E of Lake Yojoa., 14°30'N, 88°53'W, 1850–2100 m, *Allen 12301* (MO). **Cortes:** Cusuco National Park, along Río Cusuco ca. 22 km W of San Pedro Sula & 16 km S of Cuyamel, 15°31'N, 88°14'W, 1500 m, *Allen 14085* (MO). **Lempira:** Montaña de Celaque, along Río Arquegual, 7.5 km SW of Gracias, 14°34'N, 88°39'W, *Allen 11163* (MO). **Ocotepeque:** Montaña del Candado, 13 km E of Nueva Ocotepeque & Cerro El Cocal, 12 km NE of Nueva Ocotepeque, 14°27'N, 89°04'W, 2200 m, *Allen 14488A* (MO). **Santa Bárbara:** E slope of Mt. Santa Bárbara, trail to minor peak, ca. 7 km N of El Mochito, 14°55'N, 88°07'W, 2220–2640 m, *Allen 11668* (MO). **MEXICO. Hildago:** Honey Station, [20°30'N, 99°00'W], *Pringle 10487* (L, MO, NY). **PANAMA. Chiriquí:** along road to summit of Volcán Baru, 8°45'N, 82°30'W, 3000 m, *Allen 9062* (MO). **PERU. Amazonas:** Chachapoyas, km 405 on Leymebamba-Balsas road, 6°45'S, 77°48'W, 3200 m, *Smith C401C* (MO). **Apurimac:** Abancay, behind the Soccchaccasa Pass, 32 km from Abancay in the direction of Cusco, 13°36'S, 72°42'W, 4000 m, *Hegewald & Hegewald 8920* (MO). **Cajamarca:** Cajamarca, low bridge (Chalchuayacu) between Encanada and Celedin, 6°58'S, 78°15'W, 3350 m, *Hegewald & Hegewald 6614a*, (MO). **Cusco:** Anta, Indahuacho SW Cusco and Abancay, 13°28'S, 72°09'W, 3400 m, *Hegewald & Hegewald 8885* (MO). **Junín:** Huancayo, 56 km from Huancayo in direction of Parihuanca, 14 km from Chilifruta, 11°35'S, 74°35'W, 3650 m, *Hegewald & Hegewald 9270* (MO). **La Libertad:** Otuzco, near Usquil, 7°49'S, 78°25'W, 3100 m, *Hegewald & Hegewald 7203* (MO). **VENEZUELA. Mérida:** Distrito Rangel. Sierra de Santo Domingo. Paramo de Mucubaji near Laguna Negra, [8°28'N, 71°05'W], 3550 m, *Griffin et al. 960* (MO).

8. Daltonia splachnoides (Sm.) Hook. & Taylor, Musc. Brit. 80. 1818. (**Fig. 8**). *Neckera splachnoides* Sm., English Bot. 36:2564. 1814. *Hookeria splachnoides* (Sm.) Hook., English Bot. 5, 1:74. 1836, *hom. illeg.* PROTOLOGUE: IRELAND: Secawn mountain near Dublin, *D. Taylor 56* (BM!).

Daltonia angustifolia Dozy & Molk., Ann. Sci. Nat. Bot., sér. III,2:302. 1844. PROTOLOGUE: BORNEO: sine loco, *Korthals s.n.* (L!), *syn. nov.*

Daltonia pusilla Hook. f. & Wilson, Flora Tasmaniae 2:221. 1859. PROTOLOGUE: TASMANIA: near springs on Mount Wellington (very scanty specimen), growing on dead twigs, with *Hypnum aciculare*, *Oldfield 67* (NY!).

Daltonia longinervis Mitt., J. Proc. Linn. Soc. 7:163. 1863. PROTOLOGUE: [EQUITORIAL GUINEA]: Cameroon mountains and River Niger, Clarence peak, Fernando Po [Isla Bioko], with *Stereodon nitidifolius*, *Mann s.n.* (BM!, NY!), *syn. nov.*

Daltonia gracilis Mitt., J. Linn. Soc., Bot. 12:402. 1869. PROTOLOGUE: ECUADOR: Andes Quitensis, in sylva Canelos, ad folia et ramulos præcipue Bambusarum (3000 ped.), *Spruce 560* (BM!, NY!), *syn. nov.* The type at NY consist mostly of *D. gracilis* but there is a little of *D. marginata* as well. The isotype at BM consists mostly of *D. marginata*.

Daltonia fendleri Müll. Hal., Linnaea 42:491. 1879. PROTOLOGUE: VENEZUELA: circa Valencia, *Fendler 131* (FH!, H-SOL!, W!).

Daltonia angustifolia var. *gemmiphylla* M. Fleisch., Die Musci der Flora von Buitenzorg 3:959. 1908. PROTOLOGUE: WEST JAVA: Buitenzorg, am Gedeh und Pangerango (FH!), *syn. nov.*

Daltonia minuta Thér., Rev. Bryol. N. sér 3:39. 1930. PROTOLOGUE: CONGO BELGE: Mt. Ninagongo, *D. H. Linder 2170* (PC!), *syn. nov.*

Daltonia pseudostenophylla E.B. Bartram, Bernice P. Bishop Mus. Bull. 101:189. 1933. PROTOLOGUE: HAWAII: on branches in wet forest, trail to Nakalalua swamp, western Maui, alt. 4300 ft, 6 Feb 1930, *E.B. Bartram 435* (FH!), *syn. nov.*

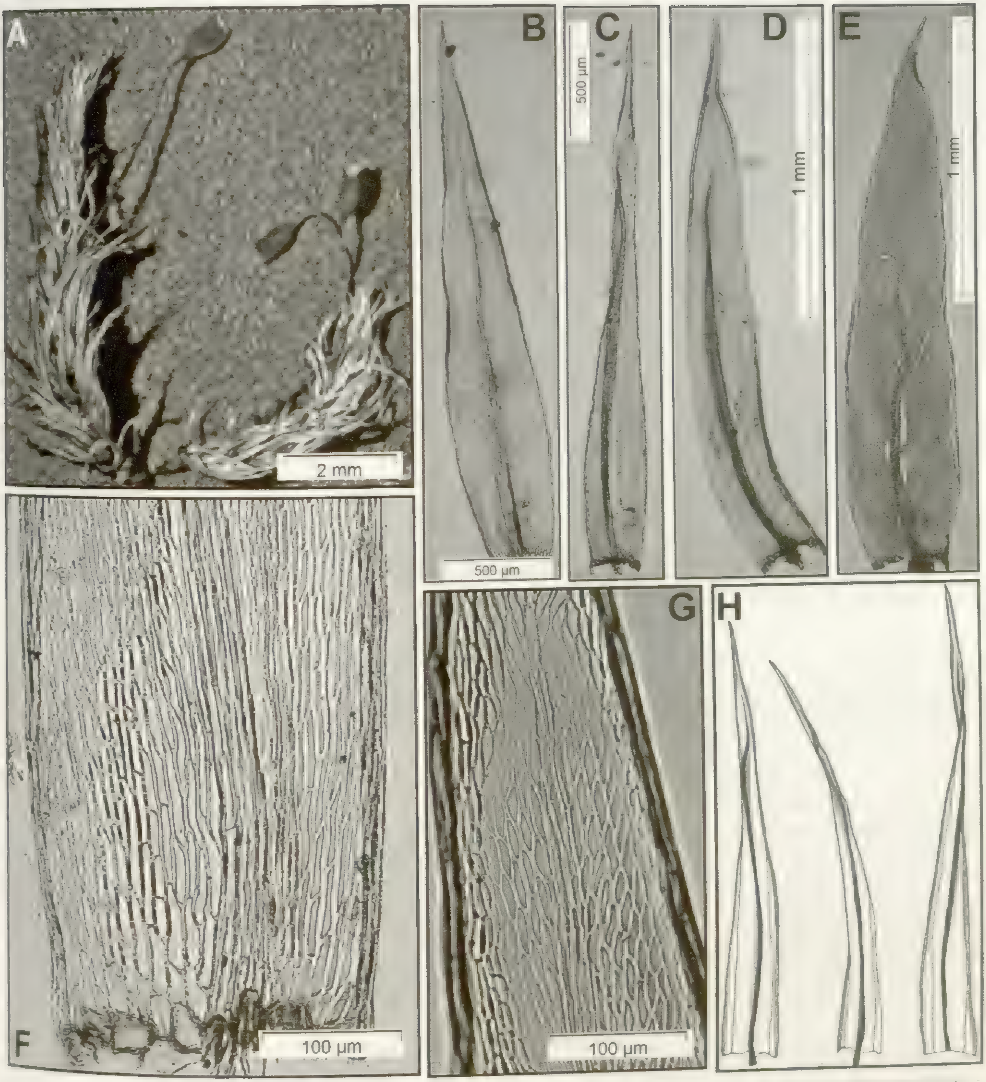

Fig. 8. *Daltonia splachnoides*. A. habit; B–E, H. leaf outlines (*H. "angustifolia"* drawn by G. Kis); F. basal lamina; G. cells of upper lamina.

Daltonia tortifolia Demaret & P. de la Varde, Bull. Jardin Bot. l'État 25:353. 1955. PROTOLOGUE: CONGO BELGE [Democratic Republic of the Congo]: District es lacs Edouard et Kivu, Ruwenzori, callon de la Kéréré, 3750 m, *Demaret 5369* (BR!), *syn. nov.*

Daltonia tristaniensis Dixon in Christopherson, Results of the Norwegian Scientific Expedition to Tristan de Cuhna 48:39. 1960. PROTOLOGUE: on tree fern, above Burntwood, Tristan de Cuhna, 600 m, 10 Jan 1938, *Christopherson & Mejland s.n.* (BM!), *syn. nov.*

Plants small, yellow-green to bronze, in small to medium-sized tufts. Stems erect, orange, 3–10 mm high, branches infrequent to common. Leaves ± erect, 1.5–2.5 mm long, linear-lanceolate, apex acute; margins narrowly recurved throughout, border 1–2 cells wide above, 5–8 cells wide at base, narrowly recurved throughout, costa ending ca. ¾–⅘ leaf length; upper cells short-linear, median and basal cells short-rectangular to short-linear, thin-walled, light to dark orange across the insertion. Asexual propagula infrequent, small (15–25 µm), orange, fusiform, occurring over the lamina. Setae generally papillose in upper half or occasionally ±

smooth, 3–6(–10) mm long; capsules brown-bronze, cylindric-ovoid, 0.5–1.2 mm long; exothecial cells rectangular to irregular; exostome yellow, papillose to spiculose; endostome segments yellow, spiculose. Spores papillose, 12–16 µm diam.

Daltonia splachnoides is the most far ranging member of the genus. It is known from all continents except Antarctica. It is perhaps due to this wide ranging existence that it bears so many superfluous names. One constant is the small size of the plants which are generally less than 6–7 mm tall although they are occasionally a little larger. Likewise the capsule is on average the smallest in the genus with perhaps the exception of *Daltonia apiculata* which is only found in southeastern Asia.

The species most likely to cause confusion in identifications of *D. splachnoides* are *D. ovalis*, *D. lindigiana* and *D. macrotheca* when these plants are on the smaller end of their size range. Characteristics useful in separating *D. splachnoides* from these three can be found under the relevant discussions above.

Illustrations.—Fig. 8; Hooker & Taylor (1818, Tab. 12); Dozy & Molkenboer (1862, Tab. 154, figs. 1–40 as *D. longipedunculata*); Fleischer (1908, fig. 165 a–i as *D. angustifolia*); Thériot (1930, fig. 7(1–8) as *D. minuta*); Bartram (1931, Pl. 4, fig. 17 *D. gracilis*); Bartram (1933, fig. 140 a–f as *D. pseudostenophylla*); Bartram (1939, Pl. 19, fig. 320 as *D. angustifolia*); Bartram (1949, fig. 131 I–J as *D. gracilis*); Welch (1966, figs. 122–130 as *D. gracilis*); Matteri (1975, Lam, III figs. 1–8 as *D. gracilis*); Gangulee (1977, fig. 735 as *D. angustifolia*); Tan & Robinson (1990, fig. 14 as *D. angustifolia*); Mohamed & Robinson (1991, figs. 23–29 as *D. angustifolia*); Sharp et al. (1994, fig. 576 a–e as *D. gracilis*); Churchill & Linares (1995, fig. 56 a–f as *D. gracilis*); Lin & Tan (1995, fig. 25 A–E as *D. angustifolia*); Buck (1998, Pl. 1, figs. 1–6 as *D. stenophylla*); Wu et al. (2002, Pl. 399, figs. 1–5 as *D. angustifolia*); Arts (2005, fig. 15, 1–12 as *D. angustifolia*).

Habitat.—Generally on twigs and tree trunks, rarely on rock or soil, occurring primarily between 1000–2700 meters but collections have been examined from near sea level to ca. 3700 meters.

Representative specimens examined: **BOLIVIA. Cochabamba:** Carrasco, Serrania Siberia, ca. 11 km oeste de El Churo, 17°45'S, 64°48'W, 2500 m, *Churchill et al. 22560-A* (MO). **La Paz:** Prov. Sud Yungas, 3.1 km SE of Unduavi bridge on old road, 16°11'S, 67°32'W, 3000 m, *Solomon 8723* (MO). **Santa Cruz:** Manuel M. Caballero 11 km este de Siberia, 1 km por San Mateo en camino Nuevo, 17°50'S, 64°41'W, 2540 m, *Churchill et al. 21884*, (MO). **Tarija:** Arce, Municipio de Padcaya. Reserva Natural Alarachi, Zona Alarachi, Cerro Los Tejerinas, 22°11'S, 64°36'W, 2025 m, *Churchill et al. 23402* (MO). **BRAZIL. Minas Gerais:** Pocos de Caldas, Morro São Domingos, 21°48'S, 46°34'W, 1580 m. *Schäfer-Verwimp & Verwimp 14424* (BR, EGR, MO). **Rio de Janeiro:** Parque National de Itatiaia, Pico das Agulhas Negras, N of Engo Passos and 13.1 km NE of União, 22°23'S, 44°41'W, 2370 m, *Vitt 21572* (MO). **Santa Catarina:** Serra Geral, Serra Rio do Rastro, ca. 12 km W of Bom Jardim da Serra on road to Lauro Muller, at rim of summit plateau, 28°22'S, 49°32'W, 1470 m, *Vital & Buck 12347* (NY). **São Paulo:** Serra de Mantiqueira, Campos do Jordão, Pico do Itapeva, 21°44'S, 46°35'W, 2020 m, *Schäfer-Verwimp & Verwimp 6925* (MO). **CANADA. British Columbia:** Bigsby Inlet, on S side of first lake, head of inlet, Moresby Island, Queen Charlotte Islands, 50°38'N, 131°46'W, [150 m], *Schofield 45167* (DUKE). **CHILI. Biobio:** Región VIII, Arauco, Huilquehue stream, 37°52'S, 73°14'W, 179m, *Ireland & Bellolio 33611* (MO). **Los Lagos:** Osorno, between El Pato and Salto del Indio, along Ruta Internacional 215, Parque Nacional Puyehue, 40°34'S, 73°09'W, 750 m, *Deguchi 31423*(HIRO). **COLOMBIA. Antioquia:** Municipio Medellín, Abajo de Boqueron, ca. 25 km NE of Medellín, 6°20'N, 75°10'W, 2500 m, *Churchill et al. 13948-B* (MO). **Boyacá:** Andes Bogatenses, Boqueron prope Bogotá, [4°55'N, 73°22'W, 2615 m], *Weir 119* (NY). **Cundinamarca:** San Cayetano, 5°18'N, 74°04'W, 2820 m. *Cleef 6592c* (U). **Nariño:** Municipio de Pasto, between km 13–15 along road from Pasto to Laguna de la Concha, 01°12'N, 77°12'W, 3000 m, *Churchill & Arbelaez 15963-b* (NY). **COSTA RICA. Alajuela:** grounds of Rancho Trebol, 10°30'N, 84°30'W, 1400 m. *Crosby 3796* (MO). **Cartago:** Dos Amigos area, near 73 km marker on Inter American Highway, SE of El Empalme, 9°37'N, 83°50'W, 2680 m, *Crosby & Crosby 5952A* (MO). **Heredia:** Las Vueltas area, 18 km N of San Jose, 10°06'N, 84°03'W, 2100 m, *Crosby & Crosby 6012*(MO). **Puntarenas:** Coto Brus Canto, 8°46'N, 83°03'W, 1250 m, *Dauphin 1981* (MO). **San José:** 13 km SE of El Empalme, 9°40'N, 83°51'W, 2600 m. *Crosby & Crosby 5833* (MO). **CUBA. Santiago de Cuba:** Sierra Maestra, Gran Piedra, 20°05'N, 75°37'W, 1130 m, *Pócs & Reyes 9047/X* (EGR). **DOMINICA. Parish St. George:** Giraudel, on the way to the summit of Mt. Anglais, 15°17'N, 61°22'W, 1 m, *Hegewald & Hegewald 9555* (MO). **DOMINICAN REPUBLIC. La Estrelleta:** Sierra de Neiba, along road from La Descubierta to Hondo Valle, from 8–15 km N of Angel Feliz, 18°42'N, 71°45'W, 1630 m, *Buck 4577* (NY). **Santiago:** Pico Diego de Ocampo, 19°35'N, 70°44'W, 1230 m. *Judd 1590* (NY). **ECUADOR. Azuay:** 21 km S of Sigsig on road to Gualaquiza, 3°06'S, 78°48'W, 2928 m, *Buck 39321A* (NY). **Morona-Santiago:** along Gualaceo-Gral, L. Plaza Gutierrez ("Limón") Hwy, 25.8 km SE of bridge at entrance to Maylas Reserva Ecologia Natural, 23.6 km SE of shrine at crest of mountain, 3°00'S, 78°27'W, *Buck 39275* (NY). **Napo:** 6 km E of Papallacta, 0°25'S, 78°05'W, 2880 m, *Buck 9993* (NY). **Pichincha:** Volcan Pichincha, N slope along trail in water catchment area (Yanacocha), 0°10'S, 78°35'W, 3700 m, *Buck 9754* (NY). **GUADALOUPE:** Basse Terre, La Soufriere. Aufstieg von der Sudostseite ostlich vom Parkplatz "Savane a Mulets," 1450 m, *Schäfer-Verwimp & Vervimp 22555* (NY). **HONDURAS. Comayagua:** Cordillera de Montecillos Montaña de San Jaunillo, trail between Cerro San Jaunillo & La Danta, 14°30'N, 87°52'W, 2020 m, *Allen 11031* (MO). **Cortes:** Cusuco National Park, along Río Cusuco ca. 22 km W of San Pedro Sula & 16 km S of Cuyamel, 15°52'N, 88°14'W, 1500 m, *Allen 14085* (MO). **Lempira:** Montaña de Celaque trail from Camp Don Tomás to first ridge.

14°34'N, 88°39'W, 2400 m, *Allen 11269* (MO). **Ocotepeque:** Montaña del Candado, 13 km E of Nueva Ocotepeque & Cerro El Cocal, 12 km NE of Nueva Ocotepeque, 14°27'N, 89°04'W, 2090 m, *Allen 14501* (MO). **Olancho:** Sierra de Algalta, Montaña Babilonia, La Picucha & saddle between peaks, 13 km NNW of Catacamas, 14°57'N, 85°55'W, 2354 m, *Allen 12736A* (MO). **JAMAICA. Parish St. Thomas:** between Portland Gap and Blue Mountain Peak, [18°15'N, 77°30'W], 2100 m, *Hegewald & Hegewald 8064* (MO). **Portland:** just N of Hardwar Gap, [18°00'N, 76°30'W], 1230 m, *Griffin 1104* (MO). **MEXICO. México:** Ocuilan, Lagunas de Zempoala, 19°40'N, 99°19'W, 2900 m, *Pócs 9546/D* (EGR). **Oaxaca:** along road N of Llano de Las Flores N of Oaxaca, [16°54'N, 96°00'W], 2250 m, *Iwatsuki & Sharp 5341* (MO). **Puebla:** between Acapulco and Cuetzalan, [19°30'N, 98°00'W], *Sharp et al. 1097-a* (MO). **Veracruz:** Jalapa Municipio, 17 km NE of Jalapa along Mex Rte 140., 19°32'N, 96°55'W, 2150 m, *Reese 4590-b* (MO). **NICARAGUA. Rivas:** Ometepe Island, [11°32'N, 85°42'W, 60 m], *B.S. s.n.* (FH). **PANAMA. Bocas del Toro:** Cerro Colorado, ca. 12 mi above Camp Chami, 8°35'N, 81°45'W, 1435 m, *Allen 5085A* (MO). **Chiriqui:** along road from gatehouse to summit of Volcán Baru, 8°45'N, 82°30'W, 3000 m, *Allen 9062A* (MO). **PERU. Amazonas:** Chachapoyas, Calla Calla between Balsas and Leimebamba, [6°13'S, 77°51'W], 3100 m, *Hegewald & Hegewald 6948a* (MO). **Apurimac:** Andahuaylas, Quebrada Pallccamayo near Huancarama, [13°39'S, 73°05'W], 3700 m, *Hegewald & Hegewald 5745* (MO). **Cajamarca:** Contumaza, Cerro Cunanten, [7°22'S, 78°51'W], 2900 m, *Hegewald & Hegewald 7326* (MO). **Cusco:** Suchubamba, just S of southern border of Manu Park on road 100, 3000 m, *Majestyk 4952* (pers. herb.). **Huanuco:** Aguas Calientes near Machu Picchu, [8°50'S, 74°41'W], 2100 m, *Hegewald & Hegewald 8790* (MO). **La Libertad:** Otuzco, near Usqui, [7°49'S, 78°25'W], 3100 m, *Hegewald &Hegewald 7203a* (MO). **PUERTO RICO. Jayuya:** high ridge trail from Toro Negro reservoir to Jayuya, [18°13'N, 66°35'W, 320 m], *Steere 6863* (NY). **VENEZUELA. Aragua:** along highway in the vicinity of Colonia Tovar, [10°25'N, 67°17'W], 1800 m, *Pursell 9294* (MO). **UNITED STATES. California:** San Francisco, Mt. Davidson summit area, [37°44'N, 122°27'W], 264 m, *Toren 9465* (pers. herb.), *Shevock 31555* (NY). **VENEZUELA. Aragua:** along highway in the vicinity of Colonia Tovar, [10°25'N, 67°17'W], 1800 m, *Pursell 9294* (MO).

APPENDIX

Index to new synonymy within *Daltonia*

D. androgyna Geh. & Hampe = **D. ovalis**
D. angustifolia Dozy & Molk = **D. splachnoides**
D. aristata Geh. & Hampe = **D. marginata**
D. brasiliensis Mitt. = **D. marginata**
D. brevinervis E.B. Bartram = **D. ovalis**
D. constricta P. de la Varde = **D. pulvinata**
D. contorta Müll. Hal. = **D. marginata**
D. contorta var. *humilis* M. Fleisch. = **D. marginata**
D. dusenii Müll. Hal. ex Broth. = **D. marginata**
D. euryloma P. de la Varde = **D. marginata**
D. flexifolia Mitt. = **D. marginata**
D. gomezii Crosby = **D. ovalis**
D. gracilis Mitt. = **D. splachnoides**
D. intermedia Renauld & Cardot = **D. marginata**
D. jamesonii var. *laevis* Herzog = **D. jamesonii**
D. latimarginata Besch. = **D. marginata**
D. latimarginata var. *madagassa* Renauld = **D. marginata**
D. latolimbata Broth. = **D. marginata**
D. longicuspidata Müll. Hal. = **D. marginata**
D. longifolia Taylor = **D. marginata**
D. longinervis Mitt. = **D. splachnoides**
D. mildbraedii Broth. = **D. pulvinata**
D. minuta Thér. = **D. splachnoides**
D. mittenii Kis = **D. marginata**
D. pellucida Herzog = **D. pulvinata**
D. peruviana Mitt. = **D. bilimbata**
D. plicata P. de la Varde = **D. marginata**
D. pseudostenophylla E.B. Bartram = **D. splachnoides**
D. rufescens Broth. = **D. ovalis**
D. stenoloma Besch. = **D. lindigiana**
D. stenophylla Mitt. = **D. lindigiana**
D. tenuifolia Mitt. = **D. macrotheca**
D. tortifolia Demaret & P. de la Varde = **D. splachnoides**
D. trachyodonta Mitt. = **D. ovalis**
D. tristaniensis Dixon in Christopherson = **D. splachnoides**

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BOOK REVIEW

Ryszard Ochyra, Halina Bednarek-Ochyra, and Ronald Ian Lewis Smith. 2008. **Illustrated Moss Flora of Antarctica.** (ISBN-10: 0521814022, ISBN-13: 978-0521814027). Studies in Polar Research. Cambridge University Press, 100 Brook Hill Drive, West Nyack, New York 10994-2133, U.S.A. (**Orders:** 800-872-7423, orders@cambridge.org). $265.00, 704 pp., 273 b/w illustrations, 42 color illustrations, 8½" × 11".

A big book format that features 42 full or half page excellent color illustrations of landscape Antarctica vistas as well as moss habitats. There are 111 Antarctica moss species described in detail found in 55 genera represented by 17 families based on the microscopic examination of approximately 10,000 specimens. This tome includes the "History of Muscological Investigations in Antarctica," "Terrestrial Environment and Moss Ecology of Antarctica," and "Systematic Accounts of the Taxa," the latter with more than 530 pages of species descriptions with full page line drawing illustrations, and sections devoted to discussion, reproduction in Antarctica, habitat, world range, distribution in Antarctica, and selected specimens examined. The keys to genera are dichotomous, reversible, and sometimes brief species descriptions instead of short couplets. The glossary has 16 pages of terms used in text narrative, species descriptions, and keys. The References on pages 607-664 contain publications mostly in the 1970 to 2007 time period sprinkled with historical papers. This book will have limited use confined mostly to bryologists, botanists, and Antarctic biologists.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

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GEOGRAPHY AND PHYLOGENY OF SEXUAL DIPLOID *ERIGERON STRIGOSUS* (ASTERACEAE) IN ARKANSAS AND MISSOURI

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ABSTRACT

Erigeron strigosus (Asteraceae) is a complex species consisting of a diversity of sexual diploid and apomictic polyploid populations. Previous work has established the geographic distribution and phylogenetic relationships among sexual diploid populations in the extreme southeastern United States. In this work we investigated disjunct sexual diploid populations in Arkansas and Missouri. We evaluated pollen quality and mapped geographic locations for 496 unique herbarium collections to determine that sexual populations are relatively common in Arkansas (37 out of 286 collections; 12.9%), especially in upland habitats in the western 2/3 of the state, but rare in Missouri (1 out of 210 collections; 0.5%). Eight rDNA (ITS plus ETS) sequences for seven populations reveal that sexual diploid *E. strigosus* from Arkansas is not genetically differentiated from other populations that have been studied. However, two genetic lineages were detected; those from the Ozark Highlands correspond to previously described rDNA haplotype II while samples from more southerly ecoregions correspond to previously described rDNA haplotype III. This work fills in a large gap in the knowledge of the distribution of genetic variation and lends insight into the phylogeography of the complex.

RESUMEN

Erigeron strigosus (Asteraceae) es un complejo de especies que consiste en una diversidad de poblaciones sexuales diploides y apomícticas poliploides. Trabajos previos han establecido la distribución geográfica y las relaciones filogenéticas entre las poblaciones sexuales diploides del extremo sureste de los Estados Unidos. En este trabajo investigamos las poblaciones sexuales diploides disyuntas de Arkansas y Missouri. Hemos evaluado la calidad del polen y mapeado las localidades geográficas de 496 colecciones de herbario únicas para determinar que las poblaciones sexuales son relativamente comunes en Arkansas (37 de 286 colecciones; 12.9%), especialmente en los hábitats de las tierras altas de los 2/3 occidentales del estado, pero son raras en Missouri (1 de 210 colecciones; 0.5%). Ocho secuencias rDNA (ITS y ETS) de siete poblaciones revelaron que el diploide sexual *E. strigosus* de Arkansas no se diferencia genéticamente de otras poblaciones que se han estudiado. Sin embargo, se detectaron dos linajes genéticos; los de Ozark Highlands que corresponden al haplotipo II de rDNA previamente descrito mientras que muestras de ecorregiones más al sur corresponden al haplotipo III de rDNA previamente descrito. Este trabajo llena un gran hueco en el conocimiento de la distribución de la variación genética y permite una percepción de la filogeografía del complejo.

INTRODUCTION

Polyploid complexes in plants present numerous challenges to evolutionary biologists especially as regards understanding the relationships between diploid progenitors and interpreting the origins of polyploids (Adams & Wendel 2005; Buggs et al. 2011). These challenges are augmented in apomictic polyploid complexes where extensive reticulation in combination with asexual reproduction yields an array of microspecies that may conceal the morphological and genetic diversity maintained by the progenitor diploid entities (Asker & Jerling 1992). Despite these challenges, noteworthy progress has been made recently in understanding the structure of apomictic complexes for a few groups using a diversity of molecular approaches (e.g., Schranz et al. 2005 [*Boechera*]; Grusz et al. 2009 [*Cheilanthes*]; Fehrer et al. 2009 [*Hieracium*]; Cosendai et al. 2011 [*Ranunculus*]).

For incompletely or poorly known complexes however, the initial step must be to comprehensively characterize diploid populations that may be progenitors of the polyploids (Stebbins 1950; Grant 1981). One such complex is the *Erigeron* sect. *Phalacroloma* (Cass.) Torr. & A. Gray (Asteraceae) apomictic complex of North America. This complex includes *Erigeron strigosus*, the prairie fleabane, which is abundant throughout eastern North America west to the Great Plains, and then occurs sporadically in suitable mesic habitats to the west coast. This species is a late spring to early summer annual to weak perennial herb from a short rhizome that

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produces one to a few erect stems ranging from ~0.4 to 1.0 m bearing terminal cymes of several to many capitula (Nesom 2006). The taxon consists of diploid (2*n*=18) populations that reproduce sexually and polyploid (triploid and tetraploid, 2*n*=27, 36) populations that reproduce asexually via apomixis (Noyes 2007).

Several investigations have aimed to understand the geographic distribution and evolutionary relationships among and between sexual diploid and polyploid apomictic *Erigeron strigosus* (Noyes 2006, 2007; Noyes & Allison 2005; Noyes et al. 2006). These studies show that sexual diploid populations occur predominantly in the South Central Plains Ecoregion of east Texas and adjacent Louisiana, Southeastern Plains Ecoregion from Alabama to South Carolina south to northern Florida, and in the Central Basin of Tennessee (ecoregions according to EPA 2011). Apomicts are sympatric and parapatric to sexual plants in these regions but represent the only condition found in the northern and western part of the species' range. This overall pattern, with geographically restricted sexual diploids, and widespread apomicts extending the range of the species is typical for apomictic groups (Bierzychudek 1985).

Studies to date show that the sexual diploid populations of *Erigeron strigosus* are morphologically and genetically diverse, constituting three subspecific taxa: *E. strigosus* var. *dolomiticola* J. Allison is restricted to a single dolomite glade complex in central Alabama; *E. strigosus* var. *calcicola* J. Allison occurs on limestone glades in the Central Basin of Tennessee and adjacent southern Alabama; *E. strigosus* var. *strigosus* applies to the remainder of sexual diploid plants that range from Texas to South Carolina across the southeast. The name *E. strigosus* var. *traversii* (Shinners) Noyes has been applied to sexual diploid plants in Texas and adjacent Louisiana (Noyes et al. 2006), but it now appears likely that these plants are genetically similar to other *E. strigosus* var. *strigosus* populations in the eastern part of the range (Noyes & Groff, unpublished data).

A phylogeny for sexual diploids in the group shows that *Erigeron strigosus* var. *calcicola* and *E. strigosus* var. *dolomiticola* are genetically distinct from *E. strigosus* var. *strigosus* (Noyes 2007). The typical variety is sister to *E. strigosus* var. *dolomiticola*, monophyletic, and genetically diverse, comprising three main rDNA lineages (haplotypes I, II, III) that are found individually and in combination in hybrids throughout the Southeast. These haplotypes are hypothesized to have evolved in isolation and then to have recombined upon range expansion into the Southeastern Plains. Hypothetical ancestral ranges of the haplotypes have not been identified.

Previous mapping and phylogenetic work for *Erigeron strigosus* has focused on the center of diversity of plants in the complex namely in Florida, Georgia, Alabama, South Carolina, Tennessee, and Texas. In the course of that work, analysis of pollen for a sample of herbarium specimens collected in Arkansas indicated that the Interior Highlands, including the Ozark Plateau and Ouachita Mountains, also likely harbored sexual diploid populations (Noyes 2007). Because of the isolation of this area from other regions where sexual diploids are found and because the Interior Highlands is an important center of endemism and biodiversity (Thorn & Wilson 1980; USDA 1999; Ouachita Ecoregional Assessment Team 2003; Robison et al. 2008), we undertook a study to determine the geographic distribution and evolutionary affinities of sexual diploid *Erigeron strigosus* in Arkansas and Missouri. We used pollen analysis from herbarium specimens to identify sexual diploid populations, mapped the populations using GIS methods, and relocated populations in the field from which DNA was isolated for phylogenetic assessment.

Our principal objectives were to determine the distribution of sexual diploid populations of *Erigeron strigosus* in Arkansas and Missouri and to evaluate the genetic relationship of these disjuncts to other sexual diploid *E. strigosus*.

METHODS

A total of 398 herbarium specimens of Arkansas and Missouri plants was borrowed from the Missouri Botanical Garden (MO; 219 specimens), the University of Arkansas at Fayetteville (UARK; 141 specimens), the University of Central Arkansas at Conway (UCAC; 22 specimens), and from the herbarium of the Arkansas Natural Heritage Commission in Little Rock (ANHC; 16 specimens). Data for these plants was appended to a database that included data gathered for 171 Arkansas and Missouri specimens studied previously (Noyes

2007) from diverse herbaria (BRIT: 49; FLAS: 1; FSU: 3; NCU: 33; TENN: 16; TEX: 29; UGA: 12; UNA: 1; USCH: 3; VDB@BRIT: 22; VSC: 2) thus yielding a total of 569 specimens examined for this study.

Pollen from herbarium specimens was evaluated to estimate mode of reproduction. For each specimen, pollen from mature but unopened florets was stained in Cotton Blue in lactophenol (Stanley & Linskens 1974, p. 307) and evaluated at 400× on an Olympus BX51 compound scope using bright field microscopy. A pollen sample was identified as being produced by a sexual diploid plant if the grains were uniformly small (ca. 12–15 μm diam.), with high viability (darkly stained), and few aborted grains (Noyes & Allison 2005). These samples are easily distinguished from polyploid apomicts which produce large pollen grains (>17 μm diam.) with high levels of pollen abortion and also usually with frequent pollen micrograins. Measurements of grains as required were performed using AnalySIS (v. 3.1; soft Imaging System, GmbH 1989–2001) on pollen images captured with an Olympus FV12 monochrome CCD camera.

The geographic coordinates for each specimen were estimated from label locality information using TOPO USA (version 5.0, DeLorme, Yarmouth, ME). The data was mapped using ESRI ArcInfo (v. 9.2, copyright 2004–2007; http://www.esri.com). Duplicate specimens were eliminated so that only unique collections were mapped. The base map providing a county boundary layer (tl_2009_US_county.shp) was obtained from the US Census Bureau, Geographic Products Branch (http://www2.census.gov/cgi-bin/shapefiles2009/national-files). As a rough check of the accuracy of our plotted data, we verified that extracted county names from plotted data points matched input county names. To evaluate the distribution of plants, we employed Level III and Level IV Ecoregion Maps (EPA 2011) for Missouri and Arkansas and determined Ecoregion for plotted points using "Join Data" in ArcInfo.

To investigate the genetic relationship of sexual diploid *Erigeron strigosus*, sexual diploid plants were collected from seven populations in Arkansas; two sites from the Ozark Highlands, three sites from the Ouachita Mountains, and two populations from northern edge of the South Central Plains (Table 1; Fig 1). Plants were evaluated in the field for pollen quality and if consistent with the sexual diploid condition brought into cultivation at the University of Central Arkansas, Conway. Chromosome counts were made to verify the diploid condition for plants using aceto-carmine root-tip squashes. Total DNA was isolated for each plant using the DNeasy Plant Mini kit (Qiagen, Valencia, California, USA). For phylogenetic analysis, rDNA ITS (ITS1, 5.8S, ITS2) and ETS regions were amplified and sequenced separately but then concatenated into a common sequence. The primers and amplification conditions were identical to those used previously (Noyes 2006). Sequencing was performed at the University of Missouri, Columbia, DNA Core Facility.

Phylogenetic analysis was conducted by adding the eight new sequences (Table 1) to a base data set consisting of sequences obtained previously for 18 plants including three samples of *Erigeron strigosus* var. *calcicola* (Ca1543.AL,Ca1540.TN, Ca1557.TN) , three samples of *E. strigosus* var. *dolomiticola* (Do1545.AL, Do1546.AL, Do1632.AL), and 12 samples representing *E. strigosus* var. *strigosus* with each of the three previously recognized haplotypes represented by four samples (haplotype I: I.1225.AL, I.1628.GA, I.1316.GA, I.1631.SC; haplotype II: II.1608.AL, II.1616.GA, II.1617.GA, II.1610.FL; haplotype III: III.1612.GA, III.1614.GA, III.1618.GA, III.1630.SC). Sample designations are the same as used previously (Noyes 2006); voucher information and GenBank Accession numbers are also reported there. Pairwise distance measures (uncorrected "p") were obtained using PAUP* (version 4.0b.10; Swofford 2002) as a measure of overall sequence similarities.

Three different approaches were used for tree construction. The first tree was constructed using weighted parsimony in PAUP* with the empirical transition/transversion ratio (Ti/Tv) = 3.68. The second was a maximum likelihood analysis executed in PAUP* using a TrN+I model of evolution selected by ModelTest 3.7 (Posada 1998) based on the Akaike Information Criterion (AIC). For each of these two analyses, statistical support was obtained via bootstrap analysis conducted in PAUP* with 100 replicates with random addition and maximum number of trees per replicate set at 1000. Lastly, a Bayesian analysis was also executed with a GTR+I model of evolution, selected by MrModelTest 2.3 (Nylander 2004), with 2000K generations and a 50% burn-in. This eliminated all sample trees with an average standard deviation of split frequencies > 0.0055.

TABLE 1. Sexual diploid *Erigeron strigosus* sampled from Arkansas, USA for phylogenetic analysis. Sample locations plotted in Figure 1.

Sample	Location	Voucher	GenBank #s [ITS,ETS]
1. ARCR63.1	AR: Izard Co.; Limestone glade 6.0 km N of Calico Rock	*RDN 1654* (UCAC)	JF937682, JF937690
2. ARCR63.2	AR: Izard Co.; Limestone glade 6.0 km N of Calico Rock	*RDN 1655* (UCAC)	JF937683, JF937691
3. ARCR64.0	AR: Stone Co.; Limestone glade 4.0 km SW of Calico Rock	*RDN 1656* (UCAC)	JF937684, JF937692
4. ARBC1	AR: Perry Co.; Big Cove Creek, disturbed forest trail; 8 km S of Nimrod Lake	*RDN 1657* (UCAC)	JF937685, JF937693
5. ARLCR1	AR: Saline Co.; Dry Lost Creek, Igneous Glade vicinity; 3.2 km S of Bauxite	*RDN 1667* (UCAC)	JF937686, JF937694
6. ARLCM1	AR: Saline Co.; Dry Lost Creek, Igneous Glade; 3.2 km S of Bauxite	*RDN 1668* (UCAC)	JF937687, JF937695
7. ARGD1	AR: Howard Co; Disturbed slopes of Gillham Lake Dam	*RDN 1661* (UCAC)	JF937688, JF937696
8. ARGDE1	AR: Howard Co; Forested roadside, 0.8 km E of Gillham Lake Dam	*RDN 1666* (UCAC)	JF937689, JF937697

RESULTS

Mode of reproduction was able to be estimated for 564 of 569 herbarium specimens. Consideration of duplicates reduced the sample to 496 unique collections. Of 287 specimens from Arkansas, 37 (12.9%) were determined to be sexual diploid and 250 (87.1%) were determined to be apomictic polyploid. Of 209 unique specimens from Missouri, the sexual diploid condition was indicated for only a single specimen (0.5%). The data pooled for both states yields 92.3% apomictic polyploid and 7.7% sexual diploid specimens (Table 2).

The map generated for the data (Fig. 1) shows that apomictic plants occur in all ten of the ecoregions recognized for the two states. Sexual diploid plants, in contrast, are restricted to six ecoregions. The lone Missouri sexual diploid collection (*E.J. Palmer s.n.*, Stone Co., MO, 19 May 1914) is from the Ozark Highlands Ecoregion in the vicinity of Galena close to the Arkansas border (Fig. 1; Table 2). In Arkansas, sexual diploid plants are present in the Ozark Highlands, Boston Mountains, Arkansas River Valley, Ouachita Mountains, South Central Plains, and Crowley's Ridge of the Mississippi Loess Plains (one collection), and completely absent from the broad Mississippi Alluvial Plain in eastern Arkansas (Fig. 1; Table 2). In the six Ecoregions of Arkansas where they occur, sexual plants are relatively frequent, representing ~11.1 percent of collections present in herbaria (Table 2). In general the sexual populations are widely distributed within Ecoregions occurring sporadically from the Oklahoma border to the edge of the Mississippi Alluvial Plain.

There are two aggregates of sexual collections, the first in north central Arkansas near the Missouri border within the Ozark Highlands (eight localities), and the second in west central Arkansas approaching the Oklahoma border in the Ouachita Mountain Ecoregion (eight localities). Most sexual populations apparently occur in close proximity to apomicts. Thus even though sexual plants are mostly restricted to the western 2/3 of Arkansas, there are no clearly defined areas where sexual plants occur exclusively. In addition, while sexual diploid plants are fairly frequent in the Ozark region of Arkansas, most of the Missouri Ozarks are devoid of sexual populations. The natural boundary for the northern extent of sexually reproducing *Erigeron strigosus* in the region thus appears to fall in extreme southern Missouri.

Herbarium specimen label data show that there is a tendency for sexual plants to be associated with specialized habitats. For instance, out of 26 collections with informative habitat label data, ten indicate 'glade' habitat, or either 'shale' or 'limestone' substrates. The other 16 collections do not indicate special edaphic habitat but are instead a diverse mixture of 'roadside', 'meadow', 'creek bed', 'clear-cut/disturbed forest', and 'rocky

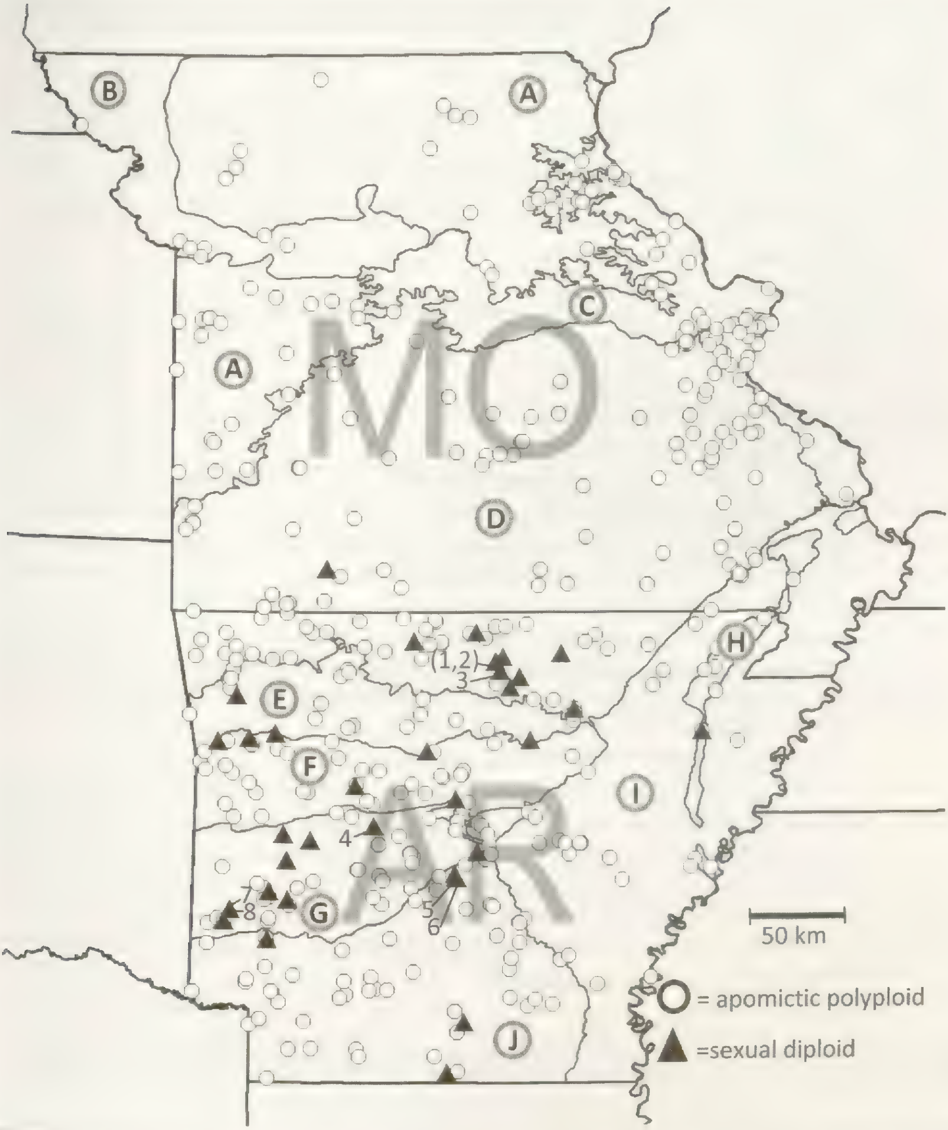

FIG. 1. Distribution of sexual diploid and apomictic polyploid *Erigeron strigosus* in Missouri and Arkansas. Mode of reproduction estimated from quality of herbarium specimen pollen. Level III Ecoregions A–J: (EPA 2011). A) Central Irregular Plains ; B) Western Corn Belt Plains; C) Interior River Lowland; D) Ozark Highlands; E) Boston Mountains; F) Arkansas River Valley; G) Ouachita Mountains; H) Mississippi Loess Plains (Crowley's Ridge); I) Mississippi Alluvial Plain; J) South Central Plains. Plotted numbers (1–8) refer to approximate localities of samples obtained for phylogenetic analysis (Table 1).

ridge'. Thus it appears that sexual plants may occur on but are not restricted to specialized edaphic habitats. Among this small sample of herbarium specimens of sexual diploid plants, there is also conspicuous morphological variation in leaf shape (narrowly linear to oblanceolate, entire to toothed basally) and pubescence (leaves and stem sparsely rough strigose to densely soft villous). However, the sexual diploids do not, based on overall morphology, fall into obvious groupings that would warrant taxonomic recognition without further study.

TABLE 2. Incidence of sexual and apomictic *Erigeron strigosus* in Arkansas and Missouri by Ecoregion (EPA 2011). Regions correspond to those depicted in Figure 1.

Region	# Apomictic Specimens	# Sexual Specimens
A. Central Irregular Plains	33 (100%)	0 (0%)
B. Western Corn Belt Plains	8 (100%)	0 (0%)
C. Interior River Lowland	58 (100%)	0 (0%)
D. Ozark Highlands	151 (92.1%)	13 (7.9%)
E. Boston Mountains	24 (88.9%)	3 (11.1%)
F. Arkansas River Valley	44 (88.0%)	6 (12.0%)
G. Ouachita Mountains	45 (83.3%)	9 (16.7%)
H. Mississippi Loess Plains (Crowley's Ridge)	9 (90.0%)	1 (10.0%)
I. Mississippi Alluvial Plain	25 (100%)	0 (0%)
J. South Central Plains	61 (91.0%)	6 (9.0%)
Total	458 (92.3%)	38 (7.7%)

Chromosome counts for all eight *Erigeron strigosus* samples selected for phylogenetic analysis showed the diploid number of $2n=18$. The eight rDNA sequences for these plants were all of identical length and similar in length to previous *E. strigosus* var. *strigosus* sequences analyzed (Noyes 2006). Alignment necessitated the addition of a single base gap in all eight sequences to accommodate the sequences of *E. strigosus* var. *calcicola* and *E. strigosus* var. *dolomiticola*. The eight new sequences exhibited very few DNA polymorphisms (14 total out of 9784 total bases; 0.14%) and all but two polymorphisms occurred in parsimony uninformative positions. It was thus inferred that the plants possessed a single predominant rDNA haplotype and were not hybrids containing two highly divergent types as had been found for plants elsewhere in the range of the species (Noyes 2006). The total aligned database for concatenated ITS (626 bp) and ETS (597 bp) was 1223 bp.

The three analytical methods resulted in the same overall phylogenetic pattern with similar levels of statistical support. The expected topology of Noyes (2006) was recovered (Fig. 2) showing *Erigeron strigosus* var. *calcicola* in a basal position, *E. strigosus* var. *dolomiticola* diverging next, and then the three clades representing the three haplotypes of *E. strigosus* var. *strigosus* with haplotype I diverging first, and haplotypes II and III as derived sisters. Each of these groups receives moderate to strong statistical support consistent with Noyes (2006). The parsimony analysis yielded 20 shortest trees the consensus of which was identical to the single trees resulting from maximum likelihood and Bayesian analyses except that the parsimony tree lacked support for one internal group within the type II clade.

All three analyses show that the Arkansas sequences fall into two groups. The three sequences from the Ozark region of northern Arkansas (ARCR63.1, ARCR63.2, ARCR64.0) unambiguously occur with type II haplotypes, the type II clade receiving bootstrap support values of 99%, 100%, and 1.0 clade credibility (Fig. 2). Further, the three Ozark sequences do not form a distinct subclade and instead occur intermixed with the other four type II sequences. The three Ozark sequences are very similar to type II sequences obtained from sexual diploid plants occurring in Florida, Georgia, and Alabama, differing by only an average of 3.8bp per sequence (average uncorrected pairwise "p" of 0.0030825). Only two base positions out of 1223 separate ARCR63.1, ARCR63.2, and ARCR64.0 from the II.1608.AL sequence from northern Alabama.

The five sequences from the southern part of the state (Ouachita Mountains and South Central Plains Ecoregions) all occur within the haplotype III clade (Fig. 2). The type III clade is moderately supported with bootstrap values for parsimony analysis and maximum likelihood of 74% and 66% respectively, and clade credibility value of 0.75 for Bayesian analysis. The five Arkansas sequences are very similar to each other as ARBC1, ARGDE1, ARLCM1, ARLCR1 are identical in sequence and differ from ARGD1 by only a single base position. The Arkansas sequences are similar to the other clade III sequences from Georgia and South Carolina yielding an average uncorrected "p" of 0.000574, an average pairwise difference of only 0.7 bases per sequence. Further, ARBC1, ARGDE1, ARLCM1, and ARLCR1 are identical to the sequences III.GA1272 and III.GA1402

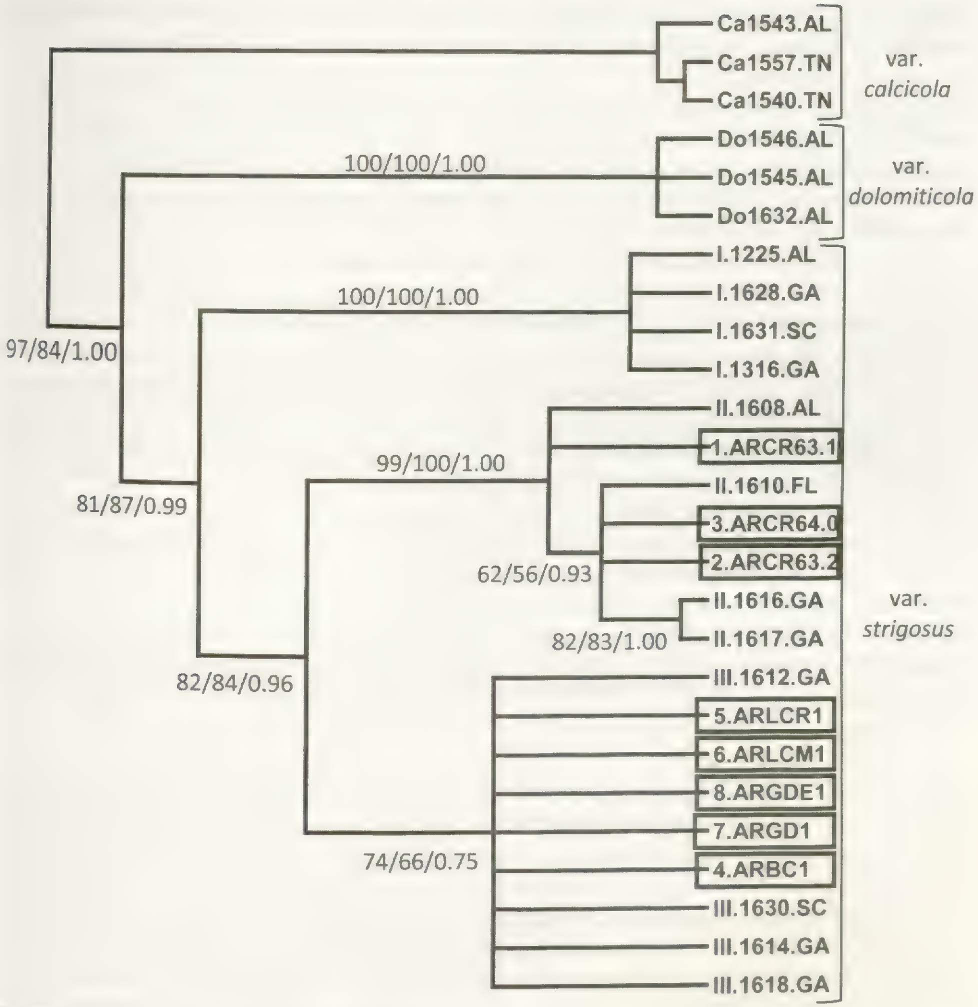

FIG. 2. Phylogenetic relationship of sexual diploid *Erigeron strigosus* from Missouri and Arkansas based on ITS plus ETS rDNA. Labels of sequences generated for this analysis are boxed. Base phylogeny consists of 18 sequences previously analyzed (Noyes 2006) including three sequences of *E. strigosus* var. *calcicola*, three sequences of *E. strigosus* var. *dolomiticola*, and 12 sequences of *E. strigosus* var. *strigosus* (4 sequences representing each of rDNA haplotypes I, II, and III). Topology is single most likely tree resulting from maximum likelihood analysis. Values associated with nodes reflect bootstrap values for weighted parsimony (Ti/Tv = 3.68), bootstrap values for maximum likelihood analysis based on TrN+I model of evolution, and clade compatibility values for Bayesian analysis based on GTR+I model of evolution.

from sexual diploid plants in Georgia. In contrast, the average pairwise uncorrected "p" distance comparing Arkansas clade II plants (ARCR63.1, ARCR63.2, ARCR64.0) with Arkansas clade III plants (ARBC1, ARGD1, ARGDE1, ARLCM1, ARLCR) is 0.0081 corresponding to about 10.0 bp.

DISCUSSION

The results of this work show that sexual diploid *Erigeron strigosus* var. *strigosus* is fairly common in Arkansas west of the Mississippi Alluvial Plain, representing about 13% of collections in herbaria from the state (Fig. 1). This extends considerably the documented range of sexual diploids from the Plains ecoregions of the Southeast

unambiguously into the four main ecoregions of the Interior Highlands: the Ozark Highlands, the Boston Mountains, the Arkansas River Valley, and the Ouachita Mountains, as well as Crowley's Ridge.

Although found in a diversity of habitats, sexual diploid plants in the region are often associated with glades or barrens. This tendency was not entirely unexpected because some members of the complex are known edaphic specialists, namely *Erigeron strigosus* var. *dolomiticola*, restricted to a single group of dolomite glades in central Alabama, and *E. strigosus* var. *calcicola*, restricted to calcareous glades in the Central Basin of Tennessee. In contrast, previous studies (Noyes et al. 2006; Noyes 2007) found that sexual diploid *E. strigosus* var. *strigosus* in the extreme Southeast in general, is not an edaphic specialist, rather preferring general sandy substrates from the Pineywoods of east Texas to the Southeastern Plains of Georgia and South Carolina. Alternative interpretations for the origin of edaphic specialization in Arkansas are possible. First, it may be that plants on these habitats are recent arrivals derived from ancestors adapted to sandy habitats from the south or southeast. That ancestral preference may then represent a predisposition for xeric and well drained soils that permitted encroachment onto more extreme glade and barren substrates of the Interior Highlands. This would be consistent with the hypothesis for the evolution of serpentine endemics (Krukeberg 1954; Pepper & Norwood 2001). Alternatively, edaphic specialization may represent the ancestral condition. In that case, plants occurring on non-specialized soils could represent recent expansion.

Phylogenetic results (Fig. 2) clearly show that sexual diploid *Erigeron strigosus* in Arkansas is not genetically distinct from populations further east. Arkansas sequences are virtually identical to sequences obtained from plants in Georgia and Alabama, and the Arkansas sequences closely align with other sequences in the rDNA type II and III clades of *E. strigosus* var. *strigosus*. Thus there is no support for an Arkansas or Interior Highlands clade. This is in contrast to the expectation, given the role of the Interior Highlands as a center of biodiversity and given their disjunct distribution, that sexual diploid *E. strigosus* found in this ecoregion would be genetically distinct.

The origin of the two rDNA haplotypes in Arkansas is unresolved as both (haplotypes II and III) are found throughout the Southeast (Noyes 2006). Instead we found two genetically distinct types both with genetic relatives in the eastern part of the range of the species. One possibility is that sexual diploid plants evolved in isolation in the Ozark and Ouachita interior highlands generating the type II and III rDNA haplotypes. Subsequent range expansion could have spread the haplotypes to the south and southeast to create the current distribution. Alternatively, the haplotypes could have arrived in Arkansas recently, having spread into the region from the south and southeast. Unfortunately with the present data, it is not possible to distinguish between these alternatives. Resolution would likely require the acquisition of population level genetic data and application of phylogeographic tools to properly model the history of the complex in the region. An additional caveat is that the current eight genetic samples from seven populations is small and may not reflect overall diversity in the region. Additional study will be required to determine the distribution, diversity, and evolutionary history of haplotypes in the region.

In contrast to sexual plants, polyploid apomictic *Erigeron strigosus* var. *strigosus* can occur in lowland regions characterized by alluvial clay soils, for instance of the Mississippi Alluvial Plain and the Interior River Lowland Ecoregions (Fig. 1). However, there is also evidence that polyploid apomicts can also occur in specialized habitats. For instance, collections by T. Witsell (ANHC) from natural areas in Arkansas that were mapped for this project show apomictic *E. strigosus* on shale glades and barrens in Saline (*Witsell 07-142, 07-145, 07-153, 07-291, 07-394*), Newton (*07-402*), and Garland (*07-181, 07-184, 07-194*) Cos., an igneous glade in Pulaski Co. (*07-260*), a dolomite glade in Marion Co. (*07-411*), and a chalk glade in Little River Co. (*07-127*). Thus it is evident that apomictic polyploid *E. strigosus* has the ability to utilize a broader spectrum of habitats than the sexual diploids. This breadth, probably in combination with asexual reproduction, likely accounts for their geographic predominance relative to sexual diploids. The polyploid condition has long been associated with expanded ecological repertoire (Ramsey & Schemske 1998; Soltis & Soltis 2000).

In contrast to their abundance in Arkansas, sexual diploid plants are apparently rare in Missouri, represented by only a single sexual diploid specimen from the southern part of the state about 35km N of the

Arkansas border. This limited distribution of sexual diploids in Missouri is somewhat surprising as suitable sites for sexual diploid plants that are comparable to those in Arkansas, for instance limestone glades, occur throughout the Ozark Highland Ecoregion of Missouri (Heikens 1999).

Finer, Level IV Ecoregion scale analysis of the distribution of sexual plants in the Ozarks shows that of the 13 sexual diploid specimens mapped, nine are located on the Springfield Plateau (including Springfield Plateau (1), Dissected Springfield-Elk River Hills (4), and the White River Hills (4; including the Missouri specimen) Ecoregions) that occupy the southwestern corner of the Ozark Highlands. The other four specimens, all in Arkansas, occur close to the Springfield Plateau but on the southern edge of the Central (or Salem) Plateau that forms the physiographic core of the Ozarks. Based on our admittedly limited sample, sexual diploids appear to be absent from the majority of the Central Plateau and also from the St. Francois Ecoregion of the Ozark Highlands. There are salient differences between the Springfield and Salem Plateaus, the former occurring at a somewhat higher elevation and overlying limestone and chert while the latter is at a somewhat lower elevation and overlies dolomite (Woods et al. 2004). It is unknown if these geologic differences or other climactic or historical events restrict sexual diploid populations to the southern part of the range surveyed. Survey of additional specimens from regional herbaria in Missouri or targeted surveying of *Erigeron strigosus* on glades and barrens in southern Missouri will be required to refine understanding of the distribution of sexual plants in the region.

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FASCICULATE MORPHOLOGY, SEED VARIATION, AND DISTRIBUTIONAL NOTES IN *ARCYTOPHYLLUM* (RUBIACEAE)

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ABSTRACT

Fasciculate morphology involving leaves and stems occurs in *Arcytophyllum fasciculatum*, *A. ericoides*, *A. rivetii*, *A. thymifolium*, and *Stenotis mucronata*. These characters are discussed and the rarity of this kind of morphology in the Rubiaceae is emphasized and compared with non-fasciculate kinds of morphology. The most noteworthy fasciculate character in four species of *Arcytophyllum* is the arrangement of the leaves in tight nodal clusters. Morphological variation in several non-fasciculate and fasciculate species is described, and a possible channel of their development is suggested. A different kind of variation having to do with the morphology of the seed hilum occurs in certain *Arcytophyllum* species The seeds of *Arcytophyllum fasciculatum* and *A. thymifolium* were found to have lengthwise- raised extensions or ridges from a punctiform center hence a new term, ridged punctiform hila. Extensions in the geographic ranges of the species *A. fasciculatum* and *A. serpyllaceum* are noted; the distribution of the genus *Arcytophyllum* is extended from South and Central America to Mexico and southwestern United States.

RESUMEN

La morfología fasciculada de las hojas y los vástagos ocurre en *Arcytophyllum fasciculatum*, *A. ericoides*, *A. rivetii*, *A. thymifolium*, y *Stenotis mucronata*. Se discuten estos caracteres y la rareza de esta clase de morfología en las Rubiaceae se acentúa y se compara con los tipos de morfología no-fasciculada. El carácter fasciculado mas significativo de cuatro especies de *Arcytophyllum* es la colocación de las hojas en racimos nodales apretados. Se describe la variación morfológica en varias especies no-fasciculadas y fasciculadas, y se sugiere una vía posible de su desarrollo. Un tipo diferente de variación que tiene relación con la morfología del hilo de la semilla ocurre en ciertas especies de *Arcytophyllum*. Las semillas de *Arcytophyllum fasciculatum* y *A. thymifolium* se encontró que tienen extensiones longitudinalmente levantadas o crestas desde un centro puntiforme por lo que se hace un nuevo término, hilos puntiformes surcados. Se observan las extensiones en los rangos geográficos de *A. fasciculatum* y de *A. serpyllaceum*; la distribución del género *Arcytophyllum* se extiende desde América del Sur y Central a México y suroeste de los Estados Unidos.

Our continuing studies of North American, including Mexican, species in the tribe Hedyotideae (s. str.) (Rubiaceae) have recently centered on the Mexican-U.S. species, *Hedyotis intricata* Fosberg. We compared this species to its closest relatives in *Arcytophyllum* Willd. ex Schult.& Schult. f. and *Stenotis* Terrell, and concluded that its greatest similarity was to *A. thymifolium* (Ruiz & Pav.) Standl. Accordingly, we formally transferred *Hedyotis intricata* to *Arcytophyllum* as *A. fasciculatum* (A. Gray) Terrell & H. Rob., while providing nomenclatural data, notes on distribution, and representative specimens (Terrell & Robinson 2010b).

In the following paragraphs we provide (1) a detailed description of *Arcytophyllum fasciculatum* along with distribution and the necessary nomenclatural data, (2) a discussion of the fascicular morphology occurring in *Arcytophyllum*, and (3) a discussion of the unusual "ridged punctiform hila" occurring in species with fascicular morphology, as shown by scanning electron microscopy, (4) Data on *Arcytophyllum serpyllaceum* and its distribution. The discussions in (2) and (3) as far as we know present new morphological data previously not known in Rubiaceae.

In our studies we have not used the genus name *Hedyotis* L., long used by Fosberg, because of our finding that many Asian and western Pacific species centered on the type species, *Hedyotis fruticosa* L., have unique

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capsule and seed morphology differing from known North American species (Terrell & Robinson 2003). Kared et al. (2008) and Groeninckx et al. (2009) have recently supported these findings and commented that all North American species named *Hedyotis* require new combinations under other generic names.

Church (2003) in a molecular study suggested that *Hedyotis intricata* (*A. fasciculata*) and relatives may belong in the *Houstonia /Stenaria* lineage, but she concluded that their placement is yet unresolved. The present placement is based entirely on structural features.

DESCRIPTION OF *ARCYTOPHYLLUM FASCICULATUM*

Arcytophyllum fasciculatum (A. Gray) Terrell & H. Rob., J. Bot. Res. Inst. Texas 4:625–626. 2010. (**Fig. 1**). *Houstonia fasciculata* A. Gray, Proc. Amer. Acad. Arts 17:203. 1882. *Hedyotis intricata* Fosberg, Lloydia 4:290. 1941, non *Hedyotis fasciculata* Bertoloni, 1850. TYPE: TEXAS: southwestern border of Texas at Presidio, Mexican Boundary Survey, *Bigelow s.n.* (LECTOTYPE: GH!, selected by Shinners, Field & Lab. 17:167.1949; ISOLECTOTYPE: K!). The syntypes below were cited by Gray following the citation of the Bigelow collection: SYNTYPES: NEW MEXICO: Organ Mountains, *G.R. Vasey s.n.*, 1881 (BM, GH, NY, US-2). MÉXICO. COAHUILA: near Parras and Monclova, *Palmer s.n.*, 1880, 404 (GH, K, MO, NA, NY, US); 406 (GH, K, NA, NY, PH, US-2).

Small shrubs. Stems to 1 m tall, woody (to 6 mm or more wide at base), stout, with many short internodes 3–15(–20) mm long, densely puberulent or pubescent with short white or gray hairs, or glabrate, exfoliating. Leaves numerous, sessile or subsessile, 2–10(–14) × 0.3–1.0 mm, appearing very small, subterete or linear, thick, rigid, falcate, densely fasciculate, clustered together at the nodes in opposite, tight groups of 3–8 or more, leaves rolled or with two grooves beneath due to being strongly revolute, glabrous or densely puberulent, apex apiculate or acute. Stipules 1–2 × 1–2 mm, whitish, deltate or truncate, apex sometimes cuspidate, with 0–few short teeth, sometimes ciliolate. Inflorescence cymose, spreading, densely and intricately branched, younger branches tetragonal, older branches becoming terete, usually densely puberulent, buds subglobose becoming oblong, flowers heterostylous, in many, small, congested groups usually 1–2 cm wide, sessile or on pedicels to 3 mm long. Hypanthium densely puberulent or glandular-puberulent; calyx lobes 0.5–2.0 × 0.8–1.0 mm, equalling or shorter than capsules, deltate, ovate, or lanceolate, obtuse. Corollas 1.5–5.5 mm long, short-funnelform, white; tubes 0.5–2.5 mm long, 1–3 mm wide at corolla throat, densely short-hairy within with brownish or whitish, occasionally clavate, flattened hairs to 0.5 mm long; lobes 1–3 × 0.7–1.0 mm, as long as or slightly longer than the tube, lanceolate or ovate, widely spreading, minutely puberulent or pubescent within, hairs white, to 0.5 mm long, denser near throat. Pin flowers with stigma lobes 0.2–0.7 mm long, linear, exserted on styles 1.2–3.0 mm beyond corolla throat, anthers ca. 0.5–1.0 mm long, narrowly oblong, subsessile at corolla throat or on filaments to 0.5 mm long. Thrum flowers with anthers 0.5–1.1 × 0.2–0.4 mm, narrowly oblong or oblong, exserted 1–2 mm beyond corolla throat on filaments to 2 mm long, stigmas exserted just distal to corolla throat. Capsules 1.6–3.0 × 1.0–2.3 mm, slightly to somewhat longer than wide, in outline oblongoid or ellipsoid, compression moderate to rather strong, appearing somewhat flattened, walls moderately thickened, lower ½ to ⅔ of capsule covered by calyx, interlocular groove often present, locules splitting apart, densely puberulent to scabrous or glabrate, apex often somewhat retuse. Seeds) (2–)6–12 per capsule, 0.8–1.5 × 0.4–0.7 mm, black or brown, rather thin, moderately to strongly compressed, oblongoid or ellipsoid, dorsal face smooth or rugose, ventral face with hilum often not clearly visible, a "ridged punctiform hilum," testa reticulate, areole walls sometimes low or depressed below the centers of the areoles.

Flowering May to November. Chromosome number: n=12 (Powell & Leavitt 2011).

Distribution.—Rocky or gravelly slopes, arroyo banks, limestone ledges and crevices of cliffs, desert, semi-desert, pine-oak, pine-juniper; 1000–2400 m. Mexico: Coahuila, western Nuevo Leon, east and central Chihuahua, north central Durango and Zacatecas; U.S.: southwestern Texas in southern Brewster (including Chisos Mts., Big Bend National Park) and Presidio counties, and southcentral New Mexico (Dona Aña and Otero counties).

Fasciculate Morphology

A study of the genus *Stenotis* by Terrell and Robinson (2010a) that includes seven annual and perennial herbs in Baja California and Arizona, noted that one species, *S. mucronata* (Benth.) Terrell, has what is termed fasciculate

FIG. 1. Plants of *Arcytophyllum fasciculatum* from Coahuila, Mexico (*Hinton 16506*, US).

morphology, in contrast to the usual morphology in the other species. We also commented that fasciculate leaf morphology also occurs in four species of *Arcytophyllum*, as discussed below.

The genus *Arcytophyllum* was revised by Mena (1990), who recognized 15 species at mostly higher elevations in Andean South America and Central America. These species are erect or prostrate shrubs and subshrubs, although two of the species, *A. filiforme* (Ruiz & Pav.) Standl. and *A. muticum* (Wedd.) Standl., may sometimes be moss-like.

In his key to all species Mena grouped three species together that possessed whorled leaves; these were *A. thymifolium*, *A. ericoides* (Willd. ex Roem. & Schult.) Standl., and *A. rivetii* Danguy & Cherm. The term whorled by our interpretation usually refers to distinct leaves arranged in a circle at a node, as in *Galium* L. (Rubiaceae). The three species here studied have as many as 8–10 or more small leaves tightly crowded together at nodes. When these species are studied, additional unusual characters are found, and these are the so-called fasciculate characters: Stems often woody and stout, upper branches many, densely branched, with many short internodes 3–15(–20) mm long (in *A. fasciculata*), leaves often sessile or subsessile, 1–8(–18) × 0.5–2(–5) mm, very small, numerous, subterete, linear, or narrowly elliptic, thick, rigid, sometimes falcate, densely fasciculate, i.e., tightly clustered at the nodes in groups of 3–8 leaves or more, often with 1–2 lines or grooves under the leaf due to the leaves being strongly revolute.

The most noteworthy characteristic of the fasciculate morphology in *Arcytophyllum* is the aforementioned tight grouping of the leaves into nodal clusters of several to 8 (10 or more) leaves (Fig. 2). The origin of these clusters is not readily determined; however, when various *Arcytophyllum* species are examined, we find variations in the branching patterns.. The non-fasciculate species, *A. nitidum* (Kunth) Schltdl., sometimes has short branches without internodes but made up of contiguous stipular nodes, called stipular because they have small stipular lateral needle-like projections such as those that are a part of the stipules in *A. nitidum*. Another non-fasciculate species, *A. setosum* (Ruiz & Pav.) Schltdl. has some branches with contiguous stipular nodes. In these species and in others there is variation in the extent of the stipular units on branches. These may be precursors to other branching patterns.

In the fasciculate species, *A. ericoides*, the nodal clusters are conspicuous features of the stems with their numerous short leaves extending at all angles from the tight clusters. Some of these clusters appear to have the dead bases of stipular remnants. This suggests that these clusters might show how the clusters were formed, i.e., the cluster was the product of more than one stipular or other unit which participated in the formation, a type of condensation, of the bases of the clusters. Similar phenomena occur in the other three fasciculate species, *A. fasciculatum*, *A. rivetii*, and *A. thymifolium*. The nodal units in *A. fasciculatum* (formerly *Hedyotis intricata*) typically show less variation and appear to be extremes of tightly clustered units. *Arcytophyllum thymifolium*, the species most similar to *A. fasciculatum*, shows more variation in this regard, but this species is notoriously variable and also has non-fasciculate colonies.

Extended Hila in Seeds

Terrell and Robinson (2004) surveyed seeds and capsules in twelve of the *Arcytophyllum* species recognized by Mena (1990). These fell into three groups. Group A included nine species that are creeping or have leaves "opposite, not whorled." These species have seeds with punctiform hila. Group B included *A. aristata* Standl. (with aristate leaves). It has what are apparently ridged hila. Group C included two species with "whorled leaves," *A. rivetii*, and *A. thymifolium*. Not examined was another whorled species, *A. ericoides*. These all have what are apparently ridged hila in contrast to all or most other *Arcytophyllum* species that have conventional punctiform hila that have variously level or slightly depressed or slightly raised dot-like centers.

By utilizing scanning electron microscopy, *Arcytophyllum rivetii* seeds were found to have small ridge-like hila, similar to the hila described below. The remaining species, *A. thymifolium*, was noted by Mena (1990) to be the most variable species in the genus. The capsules of *A. thymifolium* were 1.5–4 × 1–3 mm, often much longer than wide varying to equally long and wide, oblongoid to subglobose or ellipsoid, appearing somewhat slightly to moderately compressed, glabrous, often with an interlocular groove, dehiscing into two to four sections, ¾–⅘ inferior. We found only a few collections with seeds in reasonably good to fair condition. These

FIG. 2. Branching pattern of *Arcytophyllum fasciculatum*, showing details of tight nodal leaf clusters (*Hinton 16506*, US).

seeds were 0.8–1.5 × 0.4–0.8 mm, dark brown or black, thin or very thin, strongly compressed, with thin margins, oblongoid to broadly ellipsoid, concavo-convex or flat, sometimes with a very narrow wing at one end, and ventral face with a non-centric (acentric) hilum varying in position and extended as a ridge. We had difficulty determining whether the seeds were punctiform, i.e., hilum at a point whether slightly raised or slightly enlarged or whether they were not punctiform, i.e., more or less ridged. Study of a number of seeds from different collections has led us to conclude that the seeds of *A. thymifolium* are usually punctiform but with short or longer ridges extending from a punctiform center. In this case the punctiform hilum is centric or acentric with

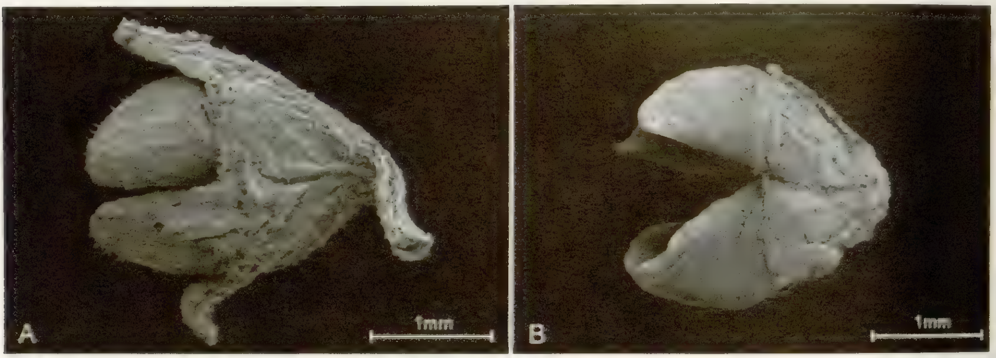

Fig. 3. Capsules of *Arcytophyllum fasciculatum* examined by SEM. Stages of dehiscence (*Chiang et al. 8913* [TEX], Chihuahua, Mexico).

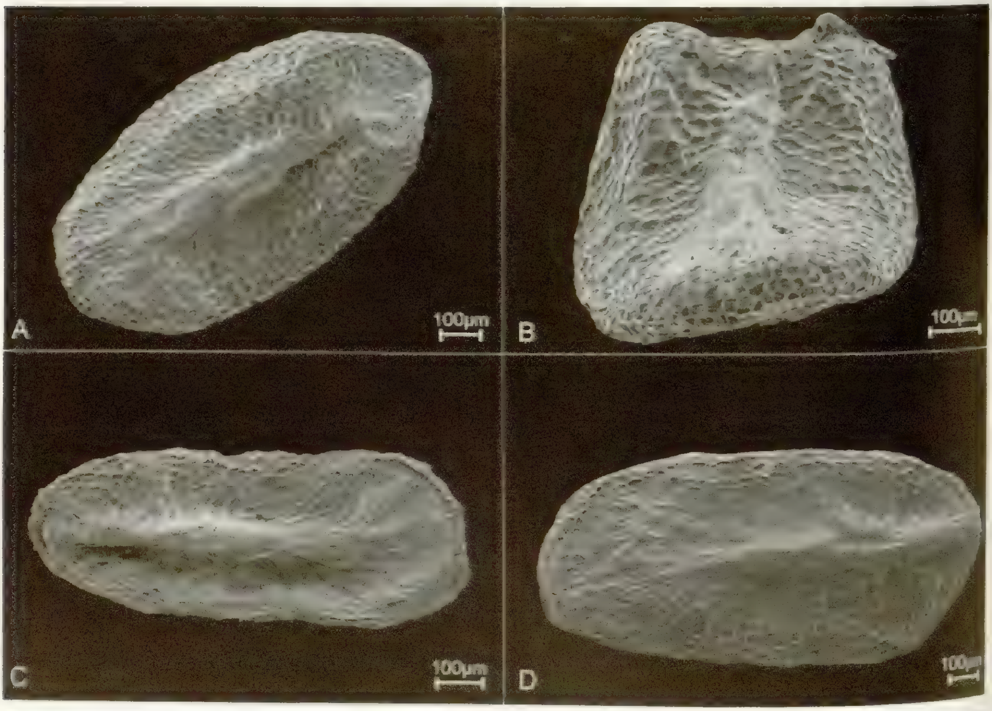

Fig. 4. Seeds of *Arcytophyllum thymifolium* examined by SEM. A–D. *Firmin 5/12/1927* (US), Ecuador. A. Hilum centric with ridge extension mainly to left. B. End view of same. C, D. Acentric hila with extended ridges.

a raised ridge visibly part of the hilum. The hilum or point of attachment is a raised center with the extended ridge attached. We have called these hilum types an extended hilum or a ridged hilum. The figures presented here show seeds with these characters.

The capsules of *A. fasciculatum* (Fig. 3) were 2–3 × 1.5–2.3 mm, usually broadly ellipsoid, strong to moderately compressed, with rounded apices. They sometimes appeared flattish (strongly compressed), but became more rounded with age and with 2-several seeds. Seeds were 0.8–1.5 × 0.4–0.8 mm, strongly to moder

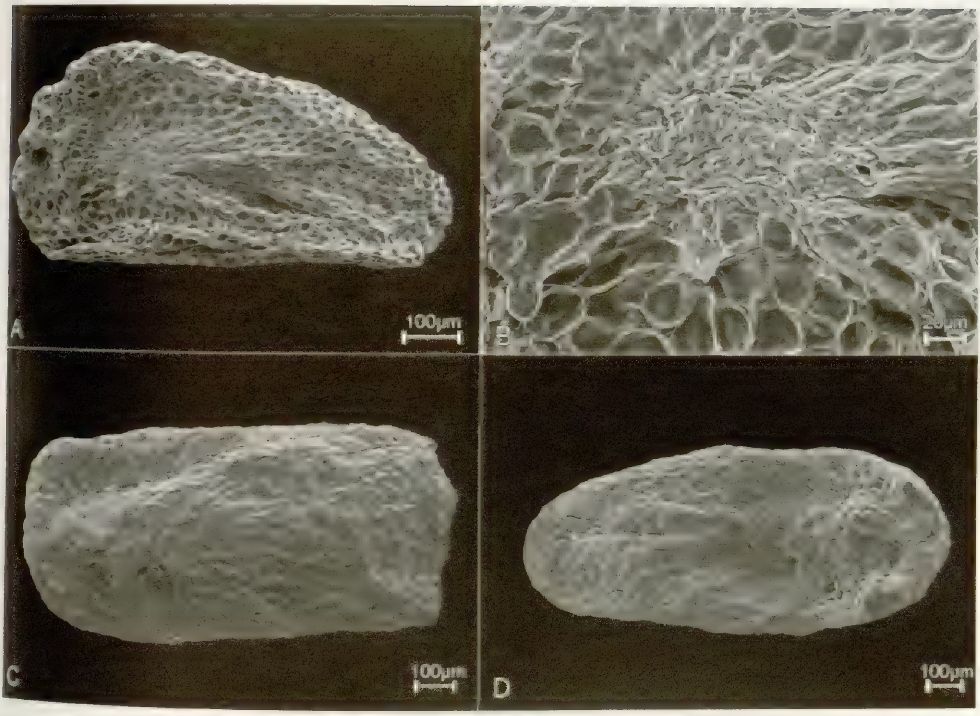

FIG. 5. Seeds of *Arcytophyllum fasciculatum* examined by SEM. A–B. *Chiang et al. 8409* (US), Chihuahua. C–D. *Chiang et al. 8913* (US), Chihuahua. A. Acentric hilum with ridge extended to right. B. Enlarged hilum of same. C, D. Acentric hila with extended ridges not clearly visible.

ately compressed, thin, ellipsoid or broadly ellipsoid. The hila in *A. fasciculatum* were found to be similar to those in *A. thymifolium*, but not as clearly evident (Figs. 4, 5). The distinction between hilum and ridge is less marked than in *A. thymifolium*; *A. fasciculatum* also has ridged or extended hila.

Our studies of fasciculate morphology and extended ridged hila provide new data not found in our previous examination of seeds of approximately 15 Rubiaceae genera.

Arcytophyllum serpyllaceum

Terrell (1999) added an additional species, *Arcytophyllum serpyllaceum* (Schltdl.) Terrell, to those then known by Mena, based on *Hedyotis serpyllacea* Schltdl., native to Guatemala and southern Mexico. This species was not included by Mena (1990), apparently because it was accepted as belonging under the genus *Hedyotis*. The species has been compared to *A. muticum* (Terrell & Robinson 2004) and shown to be very similar to it in every particular, the seeds virtually identical, and the habit very similar, often in grassy places as observed by Terrell in southern Mexico.

The relationships of *A. serpyllaceum* were questioned by Andersson et al. (2002) based on their data from the *rps*16 intron. Their results indicated that *Hedyotis serpyllaceum* was related to *Bouvardia* instead of *Arcytophyllum*, based on a Mexican collection, *Stafford et al. 203*, from the MO herbarium. To examine this collection we contacted Charlotte Taylor, curator of Rubiaceae at MO. She was unable to find this herbarium sheet, although Andersson (now deceased) earlier wrote to Terrell that the loan from GB to MO had been returned to MO. The collection, *Stafford et al. 203*, has not been found in spite of recent correspondence by Terrell and Taylor, and this problem remains unsettled. Terrell's experience with *Bouvardia* includes study of its seeds, typically with broad wings, and describing a new Mexican species.

Arcytophyllum serpyllaceum (previously known as *Hedyotis serpyllacea*) is native to Guatemala and the Mexican states of Chiapas, Oaxaca, and Veracruz, extending the range of *Arcytophyllum* as known by Mena into southern Mexico. The range of *A. fasciculatum* (formerly *Hedyotis intricata*) extends from Texas and New Mexico south into northern Zacatecas and northern Durango, thus the genus *Arcytophyllum*, known to Mena as occurring only in South and Central America, is now well established in southern and in northern Mexico and in Texas and New Mexico.

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JUSTICIA (ACANTHACEAE) IN TEXAS

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ABSTRACT

A taxonomic reassessment of *Justicia* in Texas reveals seven species (*J. americana*, *J. lanceolata*, *J. longii*, *J. pacifica*, *J. pilosella*, *J. warnockii*, and *J. wrightii*) native to diverse ecoregions and habitats in the state. *Justicia turneri* is treated as conspecific with *J. pilosella*, and *J. runyonii* is treated as conspecific with *J. pacifica*. Lectotypes are designated for *Dianthera ovata* var. *lanceolata* and *J. runyonii*. A key to species in Texas, descriptions, illustrations, synonymies, maps, habitats, and pertinent discussions are provided.

RESUMEN

Una nueva valoración taxonómica de *Justicia* en Texas revela siete especies (*J. americana*, *J. lanceolata*, *J. longii*, *J. pacifica*, *J. pilosella*, *J. warnockii*, y *J. wrightii*) como nativas de las ecorregiones y los hábitats diversos en el estado. Se reconoce a *J. turneri* como conespecífica con *J. pilosella*, y *J. runyonii* como conespecífica con *J. pacifica*. Se designan lectotipos para *Dianthera ovata* var. *lanceolata* y *J. runyonii*. Se proporciona una clave para las especies de Texas, así como sus descripciones, ilustraciones, sinonimias, mapas, hábitats, y discusiones pertinentes.

INTRODUCTION

Justicia L. encompasses some 700 species and is the largest genus of Acanthaceae. The genus is predominantly pantropical, but many species occur in subtropical and temperate regions. Fifteen species are recognized as native to or naturalized in the United States and Canada; five (*J. angusta* (Chapm.) Small, *J. crassifolia* (Chapm.) Small, *J. lanceolata* (Chapm.) Small, *J. ovata* (Walt.) Lindau, and *J. wrightii* A. Gray) of these are endemic to the United States. Because of the tropical nature of the family, most occurrences of Acanthaceae in the United States are in the mesic southeastern states (especially Florida) and in the arid and semiarid southwestern states. Texas, which has more species of Acanthaceae (47, 42 native) than any other state, occupies the boundary between these regions and as a result is enriched by species from each. Studies of the genus there should contribute toward better understanding of the taxonomy and biogeography of species in both northern North America and Mexico. Goals of this account include completing the coverage of all species of *Justicia* occurring in continental North America (north of Mexico), providing a revised treatment of taxa in Texas, and documenting and discussing distributions of species in the state. Field and herbarium studies of *Justicia* in Texas for the forthcoming *Flora of North America* have resulted in reassessments of several taxa there and recognition of seven native species in the state: *J. americana* (L.) Vahl, *J. lanceolata*, *J. longii* Hilsenb., *J. pacifica* (Oerst.) Hemsl., *J. pilosella* (Nees) Hilsenb., *J. warnockii* B.L. Turner, and *J. wrightii*.

Some species of *Justicia* native to Texas have been treated in *Adhatoda* Mill., *Dianthera* L., *Siphonoglossa* Oerst., *Rhytiglossa* Nees, *Ecbolium* Kurz, and *Monechma* Hochst.; the former three are included within *Justicia* (Graham 1988); the latter three are not, and are restricted to the Old World. Meagher (1974) studied and treated eight species of *Justicia* as native to the eastern United States and Canada; Wasshausen (1998) recognized five native species in the southeastern United States; and Daniel (1984) treated five species as native to the southwestern United States. Most of Texas is either located on the periphery of regions covered in these treatments or is beyond their geographic scope. The most comprehensive account of *Justicia* in Texas is that of Wasshausen (1966), who recognized seven species (two of them treated in *Siphonoglossa*). In spite of these studies, several taxonomic problems have persisted among Texan species. *Justicia runyonii* Small had not been compared to similar Mexican taxa, and is here treated as conspecific with *J. pacifica*. *Justicia lanceolata* had been treated both as a distinct species (Wasshausen 1966) and as a variety of *J. ovata* (Wasshausen 1998); a

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rationale is offered below for treating it at the rank of species. The putative distinctions between *J. pilosella* and *J. turneri* have never been adequately demonstrated, and they are here treated as conspecific.

Two general distribution patterns, or groups of species, are evident among *Justicia* (and most other genera of Acanthaceae) in the United States and Canada. Species in the southwestern United States (i.e., southern, central, and trans-Pecos Texas westward to southern California) are, for the most part, Mexican species at the northernmost extent of their distribution. They generally occur in biotic communities that are more extensive in Mexico, but also extend into the American Southwest (e.g., Sonoran and Chihuahuan deserts, and Tamaulipan thornscrub). These include: *J. californica* (Benth.) D.N. Gibson, *J. candicans* (Nees) L.D. Benson, *J. pacifica*, *J. pilosella*, *J. sonorae* Wassh., *J. longii*, and *J. warnockii*—four of which occur in Texas. These seven species do not appear to be closely related to one another; six of them were included in or associated with four sections of the genus by Graham (1988) and Hilsenbeck (1990). In contrast, five of the six species in the eastern United States (and Canada) are nearly or entirely endemic there, occur in wetlands, and appear to be closely related to one another (but not closely related to any of the species occurring in the American Southwest). *Justicia americana*, *J. angusta*, *J. crassifolia*, *J. lanceolata*, and *J. ovata* were treated by Graham (1988) in sect. *Dianthera* subsect. *Dianthera* (L.) V.A.W. Graham. Both *J. americana* and *J. lanceolata* occur in Texas, primarily in eastern and central portions of the state. The other putatively native *Justicia* in the eastern United States, *J. cooleyi* Monach. & Leonard, is closely related to several tropical American species of sect. *Sarotheca* (Nees) Benth. (Graham 1988), and appears to represent one of them (Daniel unpublished).

The distributions of species of *Justicia* in Texas are shown by county in Figure 1. Native species of the genus occur in 13 of the 18 ecoregions (Anonymous 2010) of Texas. Known habitats of Texan species vary from wetlands (e.g., *J. americana*) to moist forested bottomlands (e.g., *J. lanceolata*) to thornscrub (e.g., *J. pacifica*) to Chihuahuan desertscrub (e.g., *J. warnockii*).

Native species of *Justicia* in Texas can be distinguished from all other genera of Acanthaceae occurring in the state by the following combination of characters: herbs with membranaceous leaves, calyx 4- or 5-lobed, corolla limb strongly zygomorphic and with the lobes ascending cochlear in bud, upper lip of corolla rugulate, stamens 2, anthers 2-thecous with one or both thecae appendaged at base, staminodes absent, capsule with hook-like retinacula, and placentae with retinacula not separating from inner wall of mature capsule. Other characteristics of species in Texas are discussed below.

Pollen.—Pollen of *Justicia* in Texas varies from 2- to 4-aperturate (Figs. 2–3). Pollen with two apertures is most common among species in Texas, as it is among most species of *Justicia* from Mexico (Daniel 1998), but 3-aperturate (e.g., *J. longii*) and 4-aperturate (e.g., *J. warnockii* and *J. wrightii*) types are present as well. Pollen with four apertures was not recorded from the genus by Graham (1988), but has been reported in several Mexican species (Daniel 1998). The number of apertures appears to be constant within species of *Justicia*. The number of rows of insulae (when present) is sometimes variable within species, but is generally consistent as well.

Chromosome numbers.—Chromosome counts have been reported for five of the seven species that occur in Texas. Counts of n=14 have been reported for *Justicia pacifica* (as *J. caudata* A. Gray), *J. lanceolata*, *J. longii*, and *J. pilosella* (Lewis et al. 1962; Hilsenbeck 1983; Daniel et al. 1990); n=28 has been reported for *J. pilosella* (Hilsenbeck 1983); and n=13 has been reported for *J. americana* (Smith 1966). Although meiotic complements from 7 to 34 have been reported in the genus, n=14 is the most widely reported number in *Justicia* (Daniel 2000). From the counts reported, it would appear that both euploidy and dysploidy have played a role in the evolution of taxa known from Texas. The count of n=13 in *J. americana* (an apparent close relative of *J. lanceolata*), if correct, likely represents a dysploid reduction from an ancestor with n=14. The occurrence of both n=14 and 28 in *J. pilosella* reveals the presence of euploidy within that species.

Floral biology.—Most, if not all, of the species in Texas have ephemeral flowers (Fig. 4) that open and fall from the plant in the course of a single day. Ephemeral flowers have been noted on herbarium specimen labels or personally observed in *J. americana*, *J. lanceolata*, *J. longii*, and *J. pilosella*. Flowers of Texan species are mostly white to pinkish, usually with a colored palate on the lower lip (except in *J. longii* and white-flowered

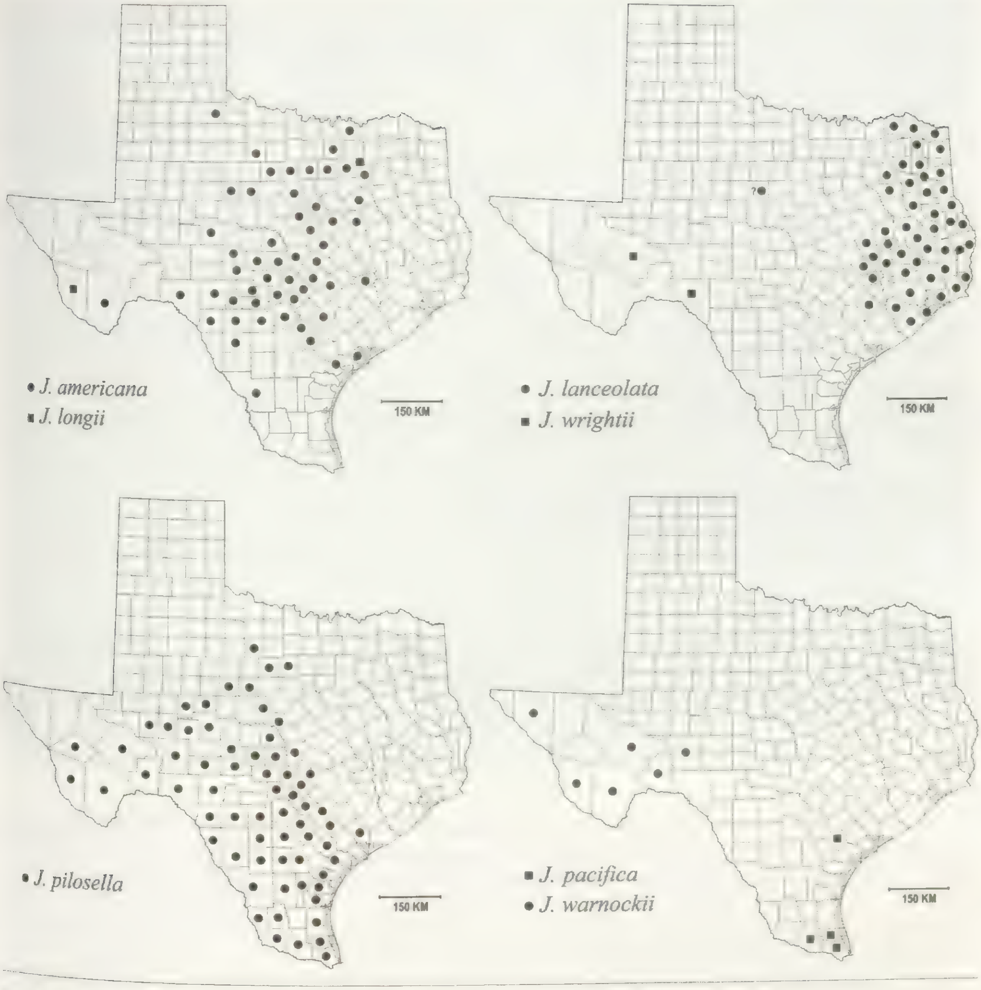

Fig. 1. Maps of Texas showing distributions of species of *Justicia* by county.

individuals of *J. pilosella*). Meagher (1974) observed bees, flies, butterflies, and ants visiting flowers of five species under cultivation in eastern North America, including *J. americana*, and *J. lanceolata*, and she suggested bee pollination for them. Robertson (1892) observed 26 floral visitors (Hymenoptera, Diptera, and Lepidoptera) to *J. americana* in July. Flowers of six of the seven species in Texas are diurnal. Hilsenbeck (1990) noted that the flowers of *J. longii* (corolla white with a long cylindric tube) open in the early evening and are visited, and possibly pollinated, by hawkmoths (e.g., Sphingidae: *Celerio*). The flowers of *J. pilosella* are similar in form to those of *J. longii*, but they are diurnal, their cylindric corolla tube is shorter, and the corolla color varies from pinkish (with a white palate) to white. These features suggest probable pollination by butterflies, bees, and/or flies in *J. pilosella*. Budlike cleistogamous flowers were observed on plants of *J. lanceolata* and *J. warnockii* early in the spring, prior to the appearance of chasmogamous flowers.

TAXONOMIC TREATMENT

Justicia L. Sp. Pl. 1:15. 1753, nomen cons. Lectotype (Hitchcock in Hitchcock and Green, International Botanical Congress, Cambridge (England), 1930: Nomenclature Proposals by British Botanists. 116. 1929): *Justicia hyssopifolia* L.

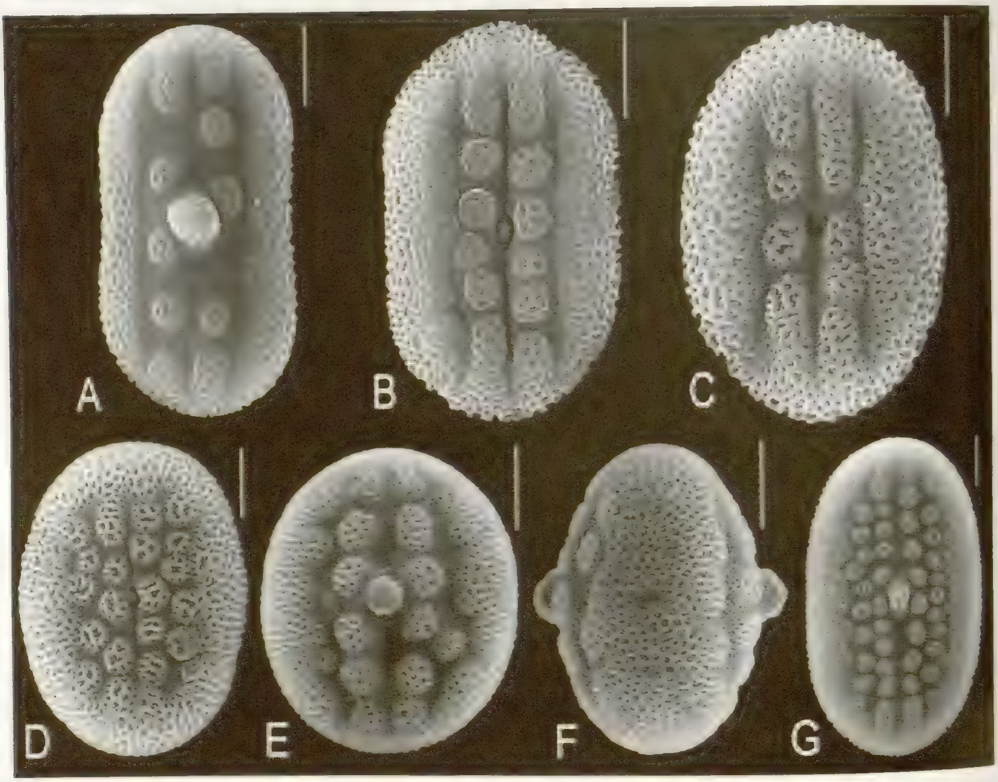

Fig. 2. Pollen of Texas species of *Justicia* with 2-aperturate grains. A. *J. americana* (*Van Devender & Van Devender 93-649*), apertural view. B. *J. lanceolata* (*Worthington 7431*), apertural view. C. *J. lanceolata* (*Worthington 7431*), apertural view. D. *J. pilosella* (*Ertter 5230a*), apertural view. E. *J. pilosella* (*Breedlove 69493*), apertural view. F. *J. pilosella* (*Breedlove 69493*), interapertural view. G. *J. pacifica* (*Ertter & Larke 5232*), apertural view. Scales=10 µm.

Dianthera L., Sp. Pl. 1:27. 1753. Type: *Dianthera americana* L. (≡*Justicia americana* (L.) Vahl).

Adhatoda Mill., Gard. Dict. Abr., ed. 4. 1: without page numbers. 1754. Lectotype (Heine, Fl. Gabon 13:173. 1966): *Adhatoda vasica* Nees (=*Justicia adhatoda* L.).

Beloperone Nees in Wall., Pl. Asiat. Rar. 3:76. 1832. Lectotype (Graham, Kew Bull. 43:609. 1988): *Beloperone amherstiae* Nees (=*Justicia brasiliana* Roth).

Jacobinia Moric., Pl. Nouv. Amer. 156. 1847. Type: *Jacobinia lepida* Nees (≡*Justicia lepida* (Moric.) Wassh.).

Siphonoglossa Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1854. 159. 1855. Type: *Siphonoglossa ramosa* Oerst. (≡*Justicia ramosa* (Oerst.) V.A.W. Graham).

Decumbent to erect perennial herbs or shrubs (to small trees) with cystoliths. Leaves opposite, sessile to petiolate, margin entire to sinuate to crenate. Inflorescence of dichasia in leaf axils (rarely in axil of 2 partially fused bracts forming a cupulate involucre) or of axillary or terminal dichasiate spikes, racemes, thyrses, or panicles; dichasia alternate or opposite, 1(–3)-flowered, subtended by a leaf or a bract, sessile or pedunculate. Bracts alternate or opposite, green or brightly colored, prominent or inconspicuous, margin entire. Flowers homostylous, sessile or pedicellate, subtended by 2 homomorphic bracteoles. Calyx deeply 4–5-lobed, lobes equal or unequal in size, posterior lobe sometimes greatly reduced in flowers with 5 calyx lobes. Corolla greenish, white, yellow, orange, pinkish, red, or purplish, usually with white or colored markings (often restricted to lower lip), tube cylindric to expanded distally, usually lacking a distinct throat, limb strongly zygomorphic, 2-labiate, upper lip internally rugulate (i.e., with a furrow in which the style is held within the upper lip), entire to 2-lobed, lower lip 3-lobed, corolla lobes imbricate (ascending cochlear) in bud. Stamens 2, inserted at vari-

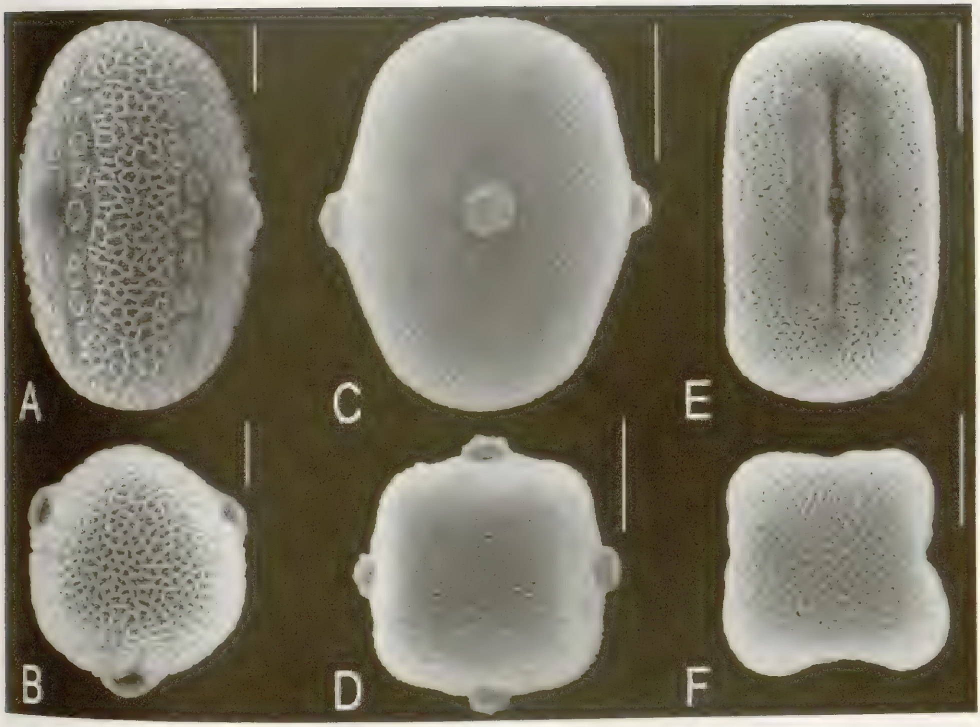

FIG. 3. Pollen of Texas species of *Justicia* with 3- or 4-aperturate grains. **A.** *J. longii* (*Reina G. et al. 2004-379*), interapertural view. **B.** *J. longii* (*Butterwick 7384*), polar view. **C.** *J. warnockii* (*Rowell 5131*), apertural view. **D.** *J. warnockii* (*Rowell 5131*), polar view. **E.** *J. wrightii* (*Turner & Turner 96-95*), apertural view. **F.** *J. wrightii* (*Turner & Turner 96-95*), polar view. Scales=10 µm.

ous positions within corolla tube, exserted from mouth of corolla, anthers 2-thecous (1 theca rarely sterile), thecae equal or unequal in length, equally inserted, unequally inserted (but overlapping for some portion of their length), or superposed (i.e., not overlapping), parallel to perpendicular, 1 or both with a basal appendage (or appendages absent), dehiscing toward lower lip (i.e., flower nototribic); pollen subprolate to perprolate, 2–4-aperturate (varying from porate to colporate with distinctness of colpi sometimes questionable), apertures flanked on each side by 1-several rows of ± circular insulae and/or peninsulae or by both a solid band of exine and a pseudocolpus, exine usually reticulate; staminodes 0 (although pubescent thickenings near attachment of filaments rarely present). Style exserted from mouth of corolla, stigma lobes indistinct to distinct, when distinct equal to unequal in length (1 lobe sometimes vestigial). Capsule stipitate, retinacula present, septa with attached retinacula remaining attached to inner wall of mature capsule. Seeds 2–4, homomorphic, discoid to globose. (x=7).

About 700 species worldwide, primarily tropical. Morphological diversity in the genus is extensive and the above description and generic synonymy are derived from North American species only. Many non-native species of *Justicia* are cultivated in the United States, both out-of-doors and under glass, but few of these persist or become naturalized. Non-native species that have been documented from cultivation in Texas are noted in the Appendix 1.

KEY TO NATIVE SPECIES OF *JUSTICIA* IN TEXAS

1. Calyx 4-lobed; seeds sometimes pubescent, never subspheric.
   2. Young stems ± evenly pubescent; leaves pubescent (trichomes sometimes restricted to margin); calyx abaxially pubescent with eglandular trichomes; bracteoles 0.5–2 mm wide; lower theca 0.8–1.3 mm long ____ **J. wrightii**

2. Young stems mostly 2-fariously pubescent; leaves glabrous; calyx abaxially glabrous; bracteoles 0.2–0.4 mm wide; lower theca 0.7–0.8 mm long ______ J. warnockii
1. Calyx 5-lobed (1 lobe sometimes reduced in size); seeds lacking trichomes (or if with deciduous trichomes to 0.05 mm long as in *J. pacifica*, then seeds subspheric).
 3. Bracteoles pubescent with eglandular and glandular trichomes (corolla tube neither elongate nor narrowly cylindric); corolla externally pubescent with glandular (and sometimes eglandular as well) trichomes; margins of calyx lobes hyaline (to whitish or much lighter green than remainder of calyx); capsule pubescent with eglandular trichomes; seed subspheric, surface smooth and shiny, covered with deciduous trichomes to 0.05 mm long ______ J. pacifica
 3. Bracteoles glabrous or pubescent with eglandular trichomes only (if with scattered glandular trichomes as rarely in *J. pilosella*, then corolla tube elongate and narrowly cylindric); corolla externally pubescent with eglandular trichomes only; margin of calyx lobes not hyaline or whitish; capsule glabrous; seeds discoid, surface rugose, papillose, or tuberculate, not shiny, lacking trichomes.
  4. Inflorescence of long-pedunculate dichasiate spikes (or panicles of spikes) to 17.5 cm long from leaf axils, peduncles of spikes to 15.5 cm; bracteoles 0.5–2.5 mm long; leaves sessile to subsessile, petioles (if present) to 2 mm long; thecae superposed (separated by a gap to 0.7 mm); corollas 7–13 mm long, tube not elongate, slightly expanded distally, shorter than to equaling limb; plants of moist regions, aquatic to subaquatic.
   5. Inflorescence spikes during anthesis subcapitate to capitate; dichasia dense (rachis not or only partially visible and internodes near midspike mostly 1–3 mm long during anthesis; internodes sometimes elongating after anthesis with rachis becoming visible), opposite at nodes; corolla white (to pale lavender) with purplish to maroon markings, lateral lobes of lower lip widely separated and diverging from central lobe at angles > 45°; plants of central, southern, and western Texas ______ J. americana
   5. Inflorescence spikes during anthesis elongate; dichasia loose (rachis clearly visible and internodes near midspike 5 mm or more long during anthesis), those above basal node alternate (i.e., 1 per node); corolla usually pinkish with maroon markings, lateral lobes of lower lip barely diverging or diverging from central lobe at angles < 45°; plants of eastern Texas ______ J. lanceolata
  4. Inflorescence of sessile to subsessile dichasia in leaf axils, peduncles of dichasia (if present) to 2 mm long; bracteoles 4–24 mm long; leaves subsessile to petiolate, petioles to 10 mm long; thecae subequally to unequally inserted (overlapping by 0.5–1 mm); corollas 12–55 mm long, tube elongate and cylindric, more than 1.5 × longer than limb; plants of arid regions, not aquatic but sometimes growing along watercourses.
   6. Corolla entirely white, 31–55 mm long; calyx lobes widest above and narrowed toward base; pollen 3-aperturate; plants known in Texas only from Presidio Co. (Chinati Mts.) ______ J. longii
   6. Corolla pinkish to purplish with white markings (rarely entirely white), 12–30 mm long; calyx lobes usually widest at base; pollen 2-aperturate; plants wide-ranging in central, southern, and western Texas ______ J. pilosella

Justicia americana (L.) Vahl, Symb. Bot. 2:15. 1791. (**Figs. 4A; 5A–C**). *Dianthera americana* L., Sp. Pl. 1:27. 1753. *Dicliptera americana* (L.) Wood, Class-book (ed. 2) 395. 1847. *Ecbolium americanum* (L.) Kuntze, Revis. Gen. 2:980. 1891. Type: U.S.A. VIRGINIA: "habitat in Virginia" (fide protologue), *Clayton 408* (LECTOTYPE, designated by Reveal in Jarvis et al. Regnum Veg. 127:42. 1993: BM-000051211).

Justicia linearifolia Lam., Tabl. Encycl. 1:41. 1791. *Dianthera linearifolia* (Lam.) Raf., Autikon Bot. 29. 1840. Type: U.S.A. "Ex Virginia, Florida … Communic. ad Fraser" (fide protologue), "à carolina. fraser" (fide specimen) (presumed HOLOTYPE: P-Lamarck; image!).

Justicia pedunculosa Michx., Fl. Bor. Amer. 1:7. 1803, nomen. superfl. (*Dianthera americana* L. cited in synonymy). *Rhytiglossa pedunculosa* (Michx.) Nees in de Candolle, Prodr. 11:339. 1847, nomen illegit.

Justicia ensiformis (Walt.) Elliott, Sketch 1:11. 1816. *Dianthera ensiformis* Walt., Fl. Carol. 63. 1788, non *Dianthera ensiformis* Wood (1870). Type: Not designated (no specimens, localities, or reference to other original materials were cited in the protologue). On making the combination in *Justicia*, Elliott noted that he had only seen specimens without flowers, and "grows in St. John's, Dr. Macbride. Flowers May."

Dianthera longifolia Raf., Autikon Bot. 30. 1840. Type: U.S.A.: "Found in R. Susquehannah" (fide protologue); no specimens seen; presumably pertains to this species.

Dianthera repanda Raf., Autikon Bot. 30. 1840. Type: U.S.A. "From Arkanzas" (fide protologue); specimens not seen; name presumably pertains to this species.

Justicia americana var. *subcoriacea* Fernald, Rhodora 43:641. 1941. *Dianthera americana* var. *subcoriacea* (Fernald) Shinners, Field & Lab. 25:79. 1957. Type: U.S.A. Texas: Tom Green Co.: S. Concho R. at Christoval, 5 Jun 1934, *V. Cory 8860* (HOLOTYPE: GH!).

Justicia mortuifluminis Fernald, Rhodora 44:92. 1942. *Justicia umbratilis* Fernald, Rhodora 43:639. 1941, non *Justicia umbratilis* S. Moore (1913). Type: U.S.A. Virginia: Southampton Co.: bottomland woods along Nottoway River, Monroe Bridge, 22 Jun 1941, *M. Fernald & B. Long 13162* (HOLOTYPE: GH!; ISOTYPES: NY! PH). See discussion below.

Aquatic or subaquatic rhizomatous or stoloniferous perennial herbs with emergent shoots to 1 m tall, sometimes forming colonies. Young stems quadrate-sulcate to ± flattened, glabrous, nodes of submerged stems sometimes with masses of fibrous roots. Leaves sessile to subsessile, petioles (if present) to 2 mm long, blades mostly ascending, linear to lance-elliptic (to elliptic) to oblanceolate to obovate, 30–125 mm long, 2.5–27 mm wide, (2–)3.3–19.5 × longer than wide, subrounded to acute at apex, acute to rounded to truncate at base.

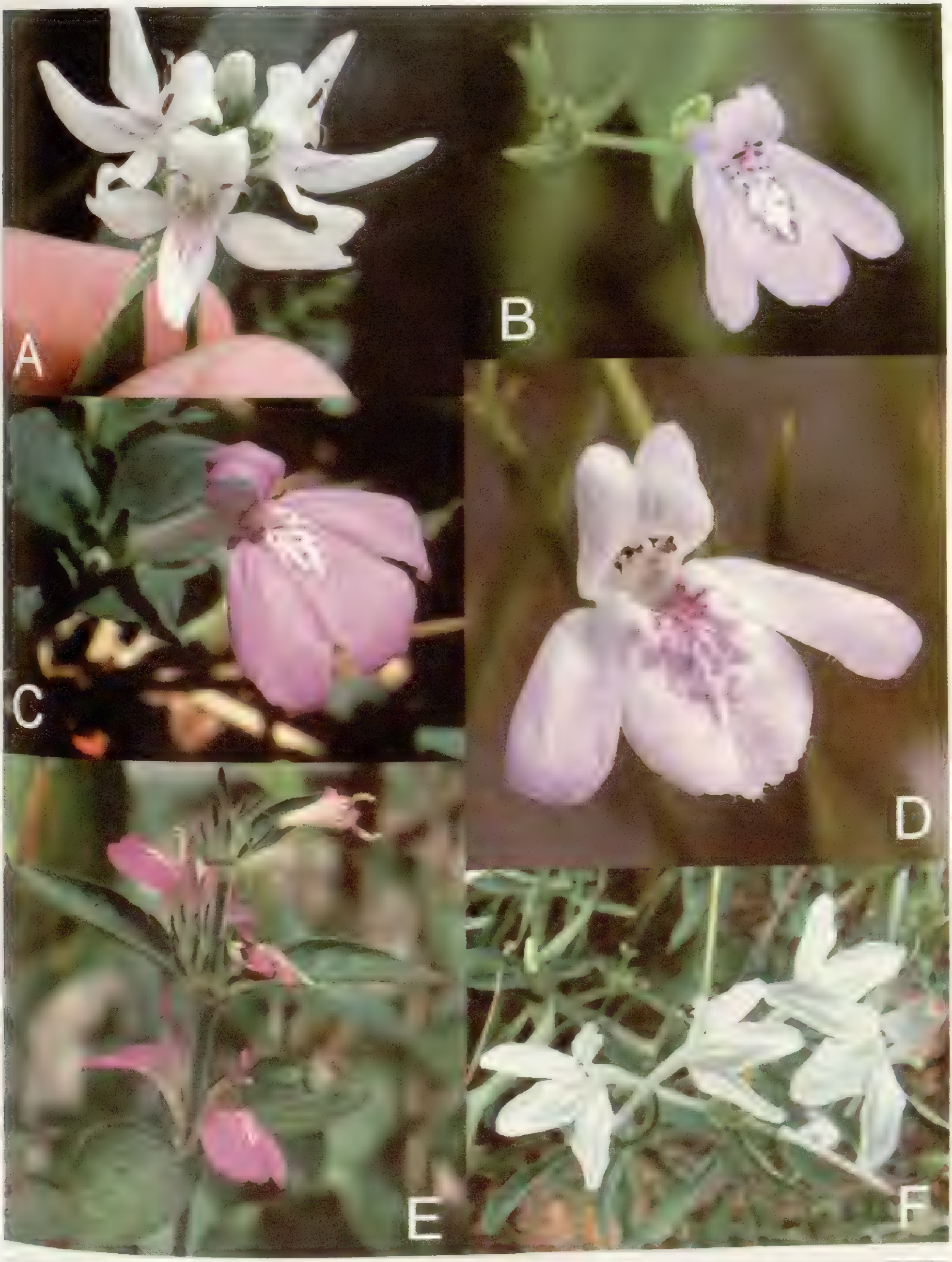

Fig. 4. Photographs of flowers of Texas species of *Justicia*. **A.** *J. americana*. **B.** *J. lanceolata*. **C.** *J. pilosella*. **D.** *J. warnockii*. **E.** *J. pacifica*. **F.** *J. longii*. Photos by author except D (R. Morey) and F (J. Verrier, taken in Arizona), which are used with permission.

Fig. 5. Texas species of *Justicia*-I. A–C. *J. americana*. **A.** Habit (*Daniel & Lott 10530*). **B.** Inflorescence node (*Van Devender 2003-820*). **C.** Seed with detail of margin (*Van Devender 2003-820*). **D–F.** *J. lanceolata*. **D.** Habit (*Palmer 7939*). **E.** Inflorescence node (*Palmer 7939*). **F.** Seed with detail of margin (*Van Devender 93-692*). **G–I.** *J. longii*. G. Habit (*Butterwick & Hillyard 7384*). **H.** Inflorescence node (*Butterwick & Hillyard 7384*) with one bracteole on right partially removed. **I.** Seed (*Reina G. et al. 2004-379*). **J–L.** *J. warnockii*. J. Habit (*Van Devender & Cohen s.n.*). **K.** Inflorescence nodes (*Van Devender & Cohen s.n.*). **L.** Seed with detail of margin (*Correll & Correll 30661*). Drawn by J. Weller.

surfaces glabrous, margin entire to crenate, eciliate. Inflorescence of axillary pedunculate densely-flowered spikes to 17.5 cm long (including peduncles and excluding corollas), peduncles to 15.5 cm long, glabrous, spikes subcapitate to capitate (internodes near midspike mostly 1–3 mm long during anthesis; sometimes elongating after anthesis), rachis usually not (or barely) visible during anthesis, glabrous; dichasia opposite at nodes, sessile, 1-flowered. Bracts triangular, 0.8–2.5 mm long, 0.8–1.2 mm wide, abaxially glabrous or very sparsely pubescent with eglandular trichomes. Bracteoles triangular, 0.5–1 mm long, 0.3–0.5 mm wide, glabrous or pubescent like bracts. Flowers sessile to subsessile (i.e., pedicels to 1 mm long). Calyx 5-lobed, 3.8–6 mm long, lobes lanceolate to lance-subulate to linear-elliptic, subequal, 3.5–5.5 mm long, 0.6–1.2 mm wide, widest near base or near midpoint, abaxially glabrous (or sparsely pubescent near apex with eglandular trichomes 0.05 mm long). Corolla white (to light purple) with purplish to maroon markings on lower lip, 8–13 mm long, externally pubescent with erect to antrorse eglandular trichomes 0.05–0.1 mm long, tube 2–4.4 mm long, slightly expanded distally, upper lip reflexed, 4–6.5 mm long, lobes 0.5–0.8 mm long, lower lip 4–10 mm long, lobes ± revolute, 3–8 mm long, lateral lobes widely separated and diverging from central lobe at angles > 45°. Stamens 6–7 mm long, thecae maroon, subparallel to perpendicular, 1.2–1.9 mm long, unequally inserted (overlapping by up to 1.2 mm) or superposed (gap to 0.3 mm long), glabrous, lacking basal appendages or the lower theca with an inconspicuous appendage 0.1 mm long; pollen 2-aperturate, apertures flanked on each side by 1 row of insulae, exine reticulate. Style 7–9 mm long, proximally pubescent with eglandular trichomes 0.05 mm long, stigma unequally 2-lobed, 1 lobe 0.2 mm long, other lobe 0.05–0.1 mm long. Capsule 9–13 mm long, glabrous. Seeds 4 per capsule, discoid, 2.8–3.5 mm long, 2.5–3.5 mm wide, surfaces covered with low, rounded (moundlike) tubercles or becoming ± rugose. (*n*=13).

Phenology.—Flowering: March–October; fruiting: April–November.

Distribution and habitats.—Canada (Ontario, Québec), United States (Alabama, Arkansas, Delaware, District of Colombia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Vermont, Virginia, West Virginia), and Mexico (Coahuila); Texas plants occur in and along rivers, streams, lakes, ditches, sloughs, often on limestone substrates, at elevations from 7 to 550(–730) m. Although its distribution includes at least nine ecoregions of Texas, it is found primarily in east-central Texas (Fig. 1) in the following regions: Cross Timbers and Prairie, Blackland Prairies, Edwards Plateau, and Stockton Plateau.

Justicia americana is the most geographically widespread species of the genus in the United States. Its distribution also extends farther northward (ca. lat. 47°N) than any other species in the family. The species is nearly endemic to the United States, but is known from nearby regions of southeastern Canada and north-central Mexico. It is the most hydrophilous among Texas *Justicia*, with the roots and proximal portion of the shoots generally submerged. It is best developed in shallows of flowing streams, but survives in wet soil above the water table and in water more than a meter deep (Penfound 1940). The species sometimes forms dense stands or colonies that spread by horizontal stolons, fragmentation of shoots, and seeds. Absence of *J. americana* from eastern Texas is somewhat surprising; however, it is uncommon in Louisiana and the other states of the northern Gulf of Mexico region. Similar habitats in eastern Texas and the northern Gulf are mostly occupied by *J. lanceolata*, the range of which only sporadically overlaps that of *J. americana*.

Unusual plants with affinities to *J. americana* were collected in Madison County (Senator Ranch, Carr Lake, 23 May 1998, *A. Neill 1888* at TAMU), somewhat to the east of the range of that species in Texas. Vegetatively, the plants resemble *J. americana* (e.g., sessile, linear leaves). However, the inflorescences consist of spikes (sometimes branched and sometimes curved) with mostly opposite dichasia 6 to 9 mm distant at the median internodes, making the rachis clearly visible. Whether such plants represent a rare or abnormal form of *J. americana*, hybrids between that species and *J. lanceolata* (which is also known from Madison County), or hybrids between *J. americana* and *J. ovata* (the nearest current occurrences of which are in southern Alabama and western Florida) remains to be determined.

At or near the type locality of *J. mortuifluminis* in southeastern Virginia, both *J. americana* and *J. ovata*, as

well as plants intermediate between them, have been collected. The density of flowering spikes of the type of *J. mortuifluminis* suggest that this name likely pertains to the synonymy of *J. americana*, but it might apply to intergrades between *J. americana* and *J. ovata*.

Representative Texas specimens examined: **Bandera Co.:** 2.5 mi E of Bandera, *D. Correll & J. Crutchfield 31078* (LL); Sabinal River Canyon, 2 mi N of Vanderpool, *D. Correll & I. Johnston 18148* (LL); 4 mi NW of Medina, *V. Cory 23530* (GH); Vanderpool, *H. Parks RX1783* (MO), *RX1784* (TEX), *RX1786* (MO). **Bastrop Co.:** Shipp Lake, between SR 71 and RR, *W. Carr 8733* (TEX); Cedar Creek at Penturf bridge, *H. Duval 156* (TEX). **Bell Co.:** W of Salado Creek Bridge on Hwy. 81, Salado Creek, Salado, *J. Massey 276* (LL, NCU, SMU); 9.3 mi W of Belton, Nolan Creek, *C. York & G. York 54226* (TEX); Salado Creek, Salado, *C. York & G. York 54586* (TEX); near Temple, *S. Wolff 2972* (US). **Bexar Co.:** San Antonio, *J. Clemens 1047* (DS, MICH, MO), *1048* (MICH, MO); Cibolo Creek, E of Bulverde, *V. Cory 6079* (GH); Selma, Cibolo River, *B. Groth 204* (CAS, F, GH, US); Comanche Spring, New Braunfels, *F. Lindheimer 64* (MO), *1061* (F, GH, TEX, UC, US); Leon Creek-Water Sommerset Rd., 9 mi SW of San Antonio, *M. Metz 2234* (UC); Helotes Creek, *E. Schulz 114* (US); San Antonio River, San Antonio, *G. Thurber s.n.* [April 1853] (F, GH), San Antonio, *E. Wilkinson 142* (MO). **Blanco Co.:** Blanco State Park, picnic area along Park Road 32, 0.1 mi W of park headquarters, banks of Blanco River, *L. Sanchez 874* (BRIT); Cypress Creek near Cypress Mill, *G. Webster 110* (DAV, TEX); Comanche Creek, on 310 11 mi W of jct. with 962, 30°55'N, 98°36'W, *G. Webster et al. 33391* (DAV). **Bosque Co.:** ca. 2 mi NW of Mosheim W from dam site along Hog Creek, *B. Lipscomb 2246* (NCU, SMU). **Brewster Co.:** near Big Bend National Park entrance, *D. Demaree 48572* (SMU). **Burnet Co.:** 1 mi E of Briggs, *J. Brenckle 48127* (SMU); Oatmeal School Creek, ca. 3 mi S of Bertram, *M. Johnston 6357* (LL, US). **Calhoun Co.:** 5 mi E of Tivoli, *C. Rogers 6619* (TEX). **Callahan Co.:** Baird, *Letterman 62* (MO). **Comal Co.:** New Braunfels, Comal River, *F. Lewton 709* (LL); Comala Creek, *F. Lindheimer 475* (MO). **Coryell Co.:** 6.2 mi E of Evant, *L. Shinners 27322* (SMU). **Cottle Co.:** Chalk Bluff, *H. Parks & V. Cory 29196* (TAES). **Dallas Co.:** "ponds n. Eagle ford," *H. Eggert s.n.* (MO); Dallas, *M. Hynes s.n.* (TEX); Tanner Rd. in NW Dallas, *B. Lipscomb 1422* (NCU, SMU, UC); Bachman Dam, *C. Lundell & A. Lundell 7034* (LL, MICH, US); Dallas, *J. Reverchon 729* (MO), *s.n.* [June 1874] (GH); White Rock Lake, Dallas, *L. Shinners 20110* (SMU, TEX); vicinity of Dallas, *M. Stephenson 90* (US). **Denton Co.:** Pilot Knob Ranch near Argyle, *D. Correll & H. Correll 23383* (F, LL); 7 mi S of Denton, *W. McCart 1098* (SMU). **Edwards Co.:** along Nueces River near Barksdale, *D. Correll & D. Wasshausen 27999* (LL, MO, SMU, US); Hackberry Creek, ca. 0.5 mi NW of Kalentine Hole, *J. Smith & M. Butterwick 266* (LL). **Erath Co.:** without locale, *L. Gough s.n.* (TEX); Stephenville, *E. Palmer 14182* (MO). **Gillespie Co.:** LBJ National Historic Park, along Pedernales River at ranch house (Texas White House), below dam, 30°15'N, 98°37'W, *R. Sanders 5111* (BRIT); Harper, *E. Whitehouse s.n.* (TEX). **Gonzales Co.:** Ottine, *E. Bogusch 3224* (TEX). **Grayson Co.:** Munson Park around Lake Denison, *H. Gentry 310* (BRIT, TEX). **Hamilton Co.:** 4 mi S of Hamilton, *R. Innes & B. Moon 1322* (F, GH, TEX); Leon River near Edson, *S. Wolff 2083* (US). **Hays Co.:** Wimberley, *G. Fisher 43045* (F); Onion Creek at I-35 overpass, *J. Mears 619* (TEX); 0.75 mi NNW of Wimberley near jct. Cypress Creek and Blanco River, *J. Walker 3* (TEX); Cypress Creek, 2 mi above Wimberley, *G. Webster 2083* (GH, TEX). **Karnes Co.:** Cibolo Creek, 1 mi SW of Pawelekville, *J. Johnson 1295* (SMU, TEX, US). **Kaufman Co.:** Seagoville Ranch, ca. 32°37'N, 96°30'W, *S. McDaniel et al. 31556* (VSC). **Kendall Co.:** 1 km E of Boerne, Cibolo Creek at Hert Rd. bridge, *C. Lieb & V. Roessling 645* (CAS). **Kerr Co.:** Verde Creek, *D. Correll & H. Correll 12804* (SMU); Kerrville, *A. Heller 1748* (MO, SMU, UC, US). **Kimble Co.:** Llano River at Junction, *D. Correll 31521* (LL); Llano River at Hwy. 385, 8 mi S of London, *D. Correll et al. 28243* (LL, US); Paint Creek, 3 mi S of Telegraph, *V. Cory 49663* (GH, SMU); South Llano River State Park, ca. 5 mi SW of Junction on US Hwy. 377, *T. Van Devender & R. Van Devender 93-649* (CAS). **Kinney Co.:** ca. 3 mi NW of jct. hwys. 277 and 693, *D. Correll & D. Wasshausen 27764* (LL, US); Las Moras Creek at Las Moras, *V. Cory 29023* (GH). **Limestone Co.:** Fort Parker State Park, Hwy. 14 and Pk. Rd. 28, *J. Singhurst et al. 1251* (BRIT). **Llano Co.:** Inks Lake State Park, *D. Correll & I. Johnston 17342* (LL, MO); City Park on Llano River, *J. Crutchfield 2313* (LL); Llano River in Llano, 30°45'N, 98°40.5'W, *A. Reina & T. Van Devender 2003-729* (CAS). **Mason Co.:** shore of Llano River, ca. 13 mi S of Mason, *Henderson 62-305* (FSU). **McLennan Co.:** 2.1 mi NNW of McGregor, *L. Shinners 14950* (SMU); North Bosque Crossing at Rapids, *L. Smith 293* (TEX); Tonkawa Park, SE of Crawford, *L. Smith 557* (TEX); gravel pit, South 3rd St., *L. Smith 811* (NY, TEX). **Medina Co.:** Medina River just S of Medina Lake, *D. Correll & E. Ogden 25359* (LL, SMU); Hondo Creek, 8 mi E of Hondo, *D. Correll et al. 28189* (LL). **Menard Co.:** Menard, *V. Cory s.n.* (TAES). **Navarro Co.:** Chambers Creek off Hwy. 31, *C. Lundell 15095* (LL, US). **Palo Pinto Co.:** 4 mi W of Palo Pinto, *D. Correll & E. Ogden 28477* (LL); without locale, *Palo Pinto School s.n.* (TEX); Brazos, *I. Parks s.n.* (TEX). **Parker Co.:** Mineral Wells State Park, *B. Lipscomb 2426* (SMU, TEX); 9.5 mi E of Weatherford, *L. Shinners 10167* (SMU). **Real Co.:** 10.8 km N of Ranch Road 1120 on US 83, *D. Boufford 10556* (A, MO); Bull Head Creek at its jct. with Nueces River, ca. 0.25 mi SW of Vance, *J. Taylor & W. Mahler 31660* (BRIT). **Refugio Co.:** Tivoli, *G. Fisher 41099* (US); Tivoli – Green Lake, *E. Whitehouse s.n.* (TEX). **Rockwall Co.:** 1.25 mi W of Rockwall, *V. Cory 53306* (GH, MICH, SMU, US). **San Saba Co.:** 6 mi SW of San Saba, *E. Howell 7* (LL); San Saba River, 20 mi S of Richland Springs, *W. McCart & R. McMillan 44* (SMU). **Stephens Co.:** Caddo Creek, ca. 2.3 mi NNE of jct. US 180 and Park Road 33 at Caddo, 32°44'35.9"N, 98°38'57"W, *W. Carr 26873* (TEX), without locale, *Tharp s.n.* (MO). **Tarrant Co.:** 6.75 mi S and 0.75 mi W of Court House, Ft. Worth, *V. Cory 54416* (LL, SMU); Boaz Park, Benbrook, *V. Cory 54479* (LL, SMU); without locale, *O. Killian 6780* (TEX); Ft. Worth, *A. Ruth 267* (F, GH, LL, MO, SMU, UC); Lake Como Park, Fort Worth, *W. Wilson & W. McCart 2190* (TEX). **Taylor Co.:** ca. 2 mi SW of Elmdale, SE of Abilene, *W. Mahler 3364* (MO, SMU); Lake Lytle near Abilene, *W. Tolstead 7281* (GH, TEX, SMU, UC); Abilene, *S. Tracy 8297* (F, GH, MO, US); Elmdale, E of Abilene, *B. Warnock 46357* (TEX, US). **Throckmorton Co.:** ca. 13 km N and 4 km W of Throckmorton, Texas A&M Experimental Ranch, *J. Cornelius 1906* (BRIT), ca. 9 mi W of Throckmorton, *D. Correll & E. Ogden 28462* (LL). **Tom Green Co.:** San Angelo, *E. Palmer 10359* (DS, MO, US); Knickerbocker Ranch, Dove Creek, *F. Tweedy 186* (US). **Travis Co.:** Slaughter Creek, Joe Carrington Farm, *C. Albers s.n.* (TEX); near Colorado River, 5 mi below Austin, *F. Barkley 13110* (MO, TEX, US); Barton Springs Creek, *F. Barkley 13642* (UC); Bull Creek, *F. Barkley & L. Ripperton 14[illegible]* (TEX); Onion Creek, *W. Brown s.n.* (TEX); Onion Creek, 8.5 mi S of Colorado River (in Austin), *D. Correll & H. Correll 29948* (LL, MO, SMU); Austin, *E. Hall 423* (F); Shoal Creek, Austin, *Heald & Wolf 653* (TEX); above Barton Springs, Austin, *W. Krodel 28* (F, MO, TEX, US); Oak Hill,

C. Lundell 15108 (LL, US); 9 mi W of Oak Hill, *C. Lundell & A. Lundell 8896* (LL, MICH, US); Bull Creek City Park on SE side of Loop 360, SW of Spicewood Springs Road, W side of Austin, *J. Saunders & B. Ertter 1323* (GH, LL); Onion Creek, Austin, *B. Tharp s.n.* (MO, UC); Shoal Creek, Austin, *B. Tharp s.n.* (UC); Austin, *B. Tharp s.n.* (TEX); near jct. Barton Creek and Little Barton Creek, ca. 1 mi SE of Bee Cave, *G. Webster 13768* (DAV, MICH, TEX); Onion Creek, *E. Whitehouse s.n.* (TEX); Walnut Creek at Water's Park, *C. York 46060* (LL, MICH, MO, UC); Austin, *H. York 80* (DS); Austin, *H. York s.n.* (TEX); Shoal Creek, Austin, *H. York s.n.* (TEX). **Uvalde Co.:** Rio Frio, Garner State Park, *D. Correll et al. 15941A* (LL); Chalk Bluff on Nueces River, *V. Cory 29197* (GH); Garner State Park, *V. Cory 49404* (GH, SMU); 2 mi NW of Utopia, Sabinal River, *W. McCart 5751* (SMU); Nueces River, Chalk Bluff, *E. Palmer 13331* (MO, US). **Val Verde Co.:** San Felipe Springs, Del Rio, *D. Correll & E. Ogden 25084* (LL, US); near mouth of Devil's River, *D. Correll & D. Wasshausen 27776* (LL, US); Sycamore Creek, *V. Cory 721* (GH); San Felipe Country Club, Del Rio, *C. Cory 41740* (GH); Devil's River at Baker's Crossing, *H. Cutler 1829* (CAS, GH, MO, WIS); fork of Devil River, Ozona-Comstock Rd., *R. Ferris & C. Duncan 3027* (MO); Del Rio, *G. Fisher s.n.* (UC); Sycamore Creek, along US 277 between Del Rio and Eagle Pass, *J. Miller et al. 5087* (MO); Devil's River, *Neally 504* (F, US); ca. 25 mi N of Comstock on SR 163, *C. Rowell s.n.* (SMU, TEX); 20.8 mi N of Comstock where Hwy. 183 crosses Devils River, *B. Turner 98.180* (TEX); Baker's Crossing of Devil's River, 33.9 km N of Comstock on TEX 163, 29°58'N, 101°09'W, *T. Van Devender & A. Reina 2003-820* (CAS). **Washington Co.:** without locale, *R. Reeves (coll. by Taber) 1896* (TAES). **Webb Co.:** 35 mi W of Laredo, *H. Hamby 1705* (LL). **Williamson Co.:** San Gabriel River at Georgetown, *J. Crutchfield 334* (LL); South Fork of San Gabriel River where it crosses Hwy. 183, N of Leander, *M. Johnston & W. McCart 5278* (NCU, TEX); Brushy Creek, just off Great Valley Dr., N of Hwy. 620, *T. Patterson 7236* (TEX); Smith Branch, Georgetown, *G. Wolcott 101* (TEX); Brushy Creek W of Round Rock, *C. York 46179* (TEX). **Wilson Co.:** Cibolo Creek, *R. Johns s.n.* (MICH); Southerland Springs, Cebelo Creek, *E. Palmer 9305* (DS, MO, US). **Zavala Co.:** Nueces River, 11.5 mi S of Uvalde, *V. Cory 11959* (GH); 10 mi N of La Pryor, Neuces River on US Hwy. 83, *E. Dickey 67* (SMU). **County undetermined**: Comings Creek, *F. Lindheimer 291* (MO); Del Rio–Eagle Pass, *E. Whitehouse* (TEX); Gonzales Marsh, *J. Normand s.n.* (TEX).

Justicia lanceolata (Chapm.) Small, Man. S.E. Fl. 1231. 1933. (**Figs. 4B; 5D–E**). *Dianthera ovata* var. *lanceolata* Chapm., Fl. South. U.S. 304. 1860. *Dianthera lanceolata* (Chapm.) Small in N.L. Britton, Man. Fl. N. States 855. 1901. *Justicia humilis* var. *lanceolata* (Chapm.) Gleason, Phytologia 4:24. 1952. *Justicia ovata* var. *lanceolata* (Chapm.) R.W. Long, J. Arnold Arbor. 51:303. 1970. Type: U.S.A. Florida: "River-banks," Jul (fide protologue), *Chapman s.n.* (lectotype, designated here: NY (ex Columbia College Herbarium; NYBG bar code 00311890!); possible isolectotype: NY ex Herbarium Columbia University, NYBG bar code 00311889!).

Mostly erect, subaquatic, perennial herbs to 3 dm tall, sometimes forming colonies. Young stems quadrate-sulcate to ± flattened, glabrous or sparsely pubescent (± evenly so or trichomes ± disposed in multiple lines) with retrorse eglandular trichomes 0.05–0.1 mm long. Leaves sessile (to subsessile), naked petioles absent or to 2 mm long, blades ascending to horizontal, elliptic to linear-elliptic to lance-elliptic (to oblanceolate), 21–59(–90) mm long, 2.5–12(–28) mm wide, (2–)3.6–13.6 × longer than wide, subrounded to acute at apex, acute at base, surfaces glabrous, margin entire to subcrenate, ciliolate. Inflorescence of axillary pedunculate loosely-flowered spikes (or branched and becoming panicles of spikes) to 120(–150) mm long (including peduncles and excluding corollas), peduncles to 60 mm long, glabrous, spike elongate (to 115 mm long), often curved, rachis clearly visible, glabrous; dichasia alternate (i.e., 1 per node) above proximalmost node, sessile, 1-flowered. Bracts triangular to subulate, 1–2 mm long, 0.5–1 mm wide, abaxial surface glabrous or pubescent with antrorse eglandular trichomes 0.05 mm long. Bracteoles subulate to lanceolate to ovate to elliptic, 1–2 mm long, 0.3–0.7 mm wide, abaxial surface glabrous or pubescent like bracts. Flowers sessile to subsessile (i.e., with pedicels to 0.5 mm long). Calyx 5-lobed, 4.5–7 mm long (up to 8 mm long in fruit), lobes linear, 4–6.2 mm long, 0.3–1 mm wide, abaxially glabrous. Corolla pale to dark pink to pinkish purple with maroon markings on lower lip, (7–)8–11(–13) mm long, externally pubescent (at least the limb) with erect to flexuose to antrorse eglandular trichomes 0.05–0.2 mm long (the tube sometimes mostly or entirely glabrous), tube slightly expanded distally, 3.5–5(–6) mm long, 1–1.8 mm in diameter, upper lip (3–)4–6 mm long, lobes 0.2–0.6 mm long, lower lip (3.5–)5–7(–9) mm long, lobes (1–)2–4.5 mm long, (0.6–)1–4 mm wide, lateral lobes barely diverging or diverging from central lobe at angles <45°. Stamens 3.5–5 mm long, filaments glabrous, thecae maroon, subperpendicular to perpendicular, superposed (gap 0.3–0.7 mm long), 0.7–1.6 mm long, unequal in size (lower theca longer), upper theca glabrous and lacking appendage, lower theca glabrous and with a basal appendage 0.05–0.2 mm long; pollen 2-aperturate, apertures flanked on each side by 1 row of insulae (insulae sometimes ± coalescing into a band), exine reticulate. Style 5–8 mm long, distally glabrous, proximally pubescent (sometimes sparsely so) with glandular and eglandular trichomes, stigma unequally 2-lobed, 1 lobe ± obsolete, up to 0.1 mm long, other lobe 0.2 mm long. Capsule 9–13 mm long, glabrous, stipe 3–5.5 mm long, head ellipsoid with slight medial constriction, 6–7.5 mm long. Seeds 4, discoid, 2–3 mm long, 1.9–2.7 mm

wide, surfaces and margin ± rugose and covered with minute trichomelike subconical papillae up to 0.05 mm long, margin not differentiated from remainder of surface (i.e., seed lacking a distinct peripheral band) or sometimes slightly thickened, entire to ± crenate.

Phenology.—Flowering: March (cleistogamous flowers only), April–October; fruiting: May–October.

Distribution and habitats.—United States (Alabama, Arkansas, Florida, Georgia, Illinois, Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, Tennessee, Texas); Texas plants occur in and along streams, roadside ditches, ponds, swamps, bayous, marshy meadows, and low/wet bottomlands at elevations from 1 to 56(–140) m. In Texas, the distribution (Fig. 1) is generally limited to the easternmost six ecoregions: Coastal Plains and Flatwoods (Western Gulf), Mid Coastal Plains (Western), Oak Woods and Prairies, Louisiana Coastal Prairies and Marshes, Eastern Gulf Prairies and Marshes, and Central Gulf Prairies and Marshes.

This species is endemic to the southeastern United States (primarily Gulf coastal plain) and the southern half of the Mississippi River valley. *Letterman 381* at F, which was collected in 1882 from Baird (Callahan County) at about 450 m elevation, pertains to *J. lanceolata*. This locality is well to the west of the range of other plants in Texas, and considerably higher in elevation. Whether presence of the species there is attributable to a labeling error for the collection or an outlying occurrence in the Rolling Plains of central Texas remains to be confirmed.

Justicia lanceolata is sometimes treated (e.g., Wasshausen 1998; Diggs et al. 1999; Wunderlin and Hansen 2003) as a variety of *J. ovata*, a species of Alabama, Florida, Georgia, North Carolina, South Carolina, and Virginia, that occurs primarily in the Atlantic coastal plain. Morphological distinctions and tendencies between *J. lanceolata* and *J. ovata* from throughout their ranges are summarized in the couplet below. The differences appear to be as significant as those between other species of the genus in the eastern United States, and fewer plants with characters intermediate between these two taxa have been encountered than between other pairs (e.g., *J. ovata* and *J. americana*; cf. Beal and Brown 1976) with overlapping distributions.

1. Spike not secund, dichasia opposite (i.e., paired at inflorescence nodes); leaves subsessile to petiolate, petioles to 6 mm long ____ **J. ovata**
1. Spike secund, dichasia above basal node alternate (i.e., solitary at inflorescence nodes); leaves sessile to subsessile, petioles to 2 mm long ____ **J. lanceolata**

Although there is overlap in leaf shape and size, in general leaves of *J. lanceolata* tend to be narrower than those of *J. ovata*. The inflorescence character provides a much better means of distinguishing between these taxa. Another character that might help to distinguish these species is the relative positions of the two thecae of an anther. Among limited specimens examined from throughout their ranges, thecae of *J. lanceolata* are superposed (either contiguous or with a gap between them to 0.7 mm), whereas those of *J. ovata* are unequally inserted (overlapping by up to 0.3 mm). There is little question that these two species are similar and likely closely related. Their distributions overlap in southern Georgia, north-central to northwestern Florida, and southern Alabama.

Chapman (1860) did not cite a type or specimens from which to choose one in his protologue. The types of names in Chapman's 1860 *Flora of the Southern United States* went to Columbia College/University (Stafleu and Cowan 1976), and are now at NY. There are two specimens at NY (ex Columbia) that likely represent syntypes of this species. One was collected by Chapman in Florida; the other bears a label of the Chapman Herbarium and was also collected in Florida. Both bear Chapman's name in what appears to be his handwriting, correspond to the protologue, and represent *J. lanceolata*. The specimen with the printed "Herb. Chapman" label is a more complete specimen and is designated as the lectotype above. The other specimen is likely a duplicate of this collection.

Additional Texas specimens examined: **Angelina Co.:** 0.25 mi S of Angelina River on US Hwy. 59, *V. Cory 56747* (SMU); Bodan Creek, 6 mi SE of Wells, *L. Shinners 24446* (SMU). **Bowie Co.:** 7 mi W of Texarkana on Hwy. 82, *E. Whitehouse 21417* (SMU). **Brazoria Co.:** San Bernard Refuge, *R. Fleetwood 9759* (TEX); Eaglenest Lake, 10 mi N of West Columbia, *R. Fleetwood 10354* (MO). **Brazos Co.:** banks of Navasota River near mouth of Carters Creek, *P. Fryxell 1852* (BRIT, NY); Bryan, *E. Palmer 11761* (GH, MO, NY, US); E of Bryan, *R. Reeves 356* (US); Navasota River, *R. Reeves 357* (US). **Burleson Co.:** 6 mi W of Snook on Hwy. 60, *P. Fryxell 3118* (MICH, NY, SMU, TEX). **Callahan Co.:** Baird, *G. Letterman 381* (F). **Cass Co.:** Cypress Creek on Hwy. 11 E of Hughes Springs, *E. Whitehouse 20277* (SMU). **Chambers Co.:** Trinity River bot-

toms, ca. 2 mi N of Cove on Texas Hwy. 73, *A. Traverse 794* (LL, SMU); 7.8 mi N of High Island, *V. Cory 20212* (GH); between RR tracks and Hwy. 124, 4.6 mi S of Winnie (ca. 25 mi SW of Beaumont), *M. Lelong s.n.* (NCU); along I-10 at Trinity River Bridge and town of Wallisville, *R. Worthington 7431* (CAS). **Cherokee Co.:** ca. 14.5 mi SE of Troup, ca. 5.7 mi N of Hwy. 79, *G. Ajilvsgi 6724* (BRIT). **Colorado Co.:** Columbia, *Bush 1496* (MO); Altair, *B. Tharp 2669* (TEX, US). **Fort Bend Co.:** Hale Ranch, 16 mi SE of Rosenberg, *L. Lodwick & B. Snyder 564* (BRIT); rest area on I-10 at Brookshire (ca. 20 mi W of edge of Houston), *T. Van Devender & R. Van Devender 93-692* (ARIZ, CAS). **Galveston Co.:** 0.25 mi N of Link Road behind old Bradshaw Nursery, League City, *F. Waller 3807* (GH, TEX). **Gregg Co.:** without locality, *York s.n.* (TEX). **Grimes Co.:** FM 244, 0.9 mi S of Hwy. 30, *S. Jasper E04-2* (TAMU). **Hardin Co.:** near Sour Lake, Sour Lake – Beaumont road, above Pine Island Bayou, *C. Lundell & A. Lundell 14107* (LL, SMU, US); 7 mi N of Kountze, *E. Whitehouse 23289* (SMU). **Harris Co.:** Houston, *B. Bush 256* (MO); vicinity of Houston, *R. Dixon 620* (F); Houston, *G. Fisher 1739* (US), *s.n.* (UC); Houston, *E. Hall 424* (F, GH, MO, NY, US); Houston, *E. Johnston s.n.* (DAV); 5 mi W of Houston, White Oak Bayou, *F. Lindheimer 159* (F, GH, MO, UC); near Houston, *F. Lindheimer s.n.* (SMU). **Harrison Co.:** 2.75 mi E of Karnack, *V. Cory 22889* (GH); Caddo Lake State Park, near boat ramp, *R. Fleetwood 12243* (BRIT). **Henderson Co.:** just S of Chandler on rte. 315, Kickapoo Creek, *D. Correll & H. Correll 28537* (US); off Hwy. 31, Cedar Creek, E of Trinidad, *C. Lundell 15097* (LL, US); 9.5 mi S of Athens, *L. Shinners 19125* (SMU). **Houston Co.:** Grapeland, *LeSueur & Smith s.n.* (PH, TEX). **Jasper Co.:** 2.33 mi S of Jasper, *V. Cory 56580* (SMU, US). **Jefferson Co.:** 5 mi S of Grayburg, *D. Correll 16471* (LL, SMU). **Lamar Co.:** Hinckley, *F. Thurow s.n.* (US). **Leon Co.:** Fort Boggy State Park, 4 mi S of Centerville on Hwy. 75, *E. Nixon 17715* (BRIT); 4.8 mi S of Centerville, *L. Shinners 24282* (SMU). **Liberty Co.:** jct. Trinity River and Hwy. 105, *E. Nixon 4201* (NCU); 1 mi W of Hardin Co. on Texas Hwy. 105, *R. Thomas et al. 39733* (BRIT). **Madison Co.:** CR 431, ca. 5.3 mi W of North Zulch, *A. Neil 59* (TAMU); Navasota River at Hwy. 21 bridge, *A. Neill 284* (TAMU). **Montgomery Co.:** without locality, *R. Dixon 496* (F); 13 mi S of Conroe, Hwy. 75, *B. Turner 2910* (SMU). **Nacogdoches Co.:** 10.5 mi SW of Nacogdoches, *V. Cory 10677* (GH), *10678* (GH). **Newton Co.:** without locality, *Tharp s.n.* (TEX). **Orange Co.:** N of Neches River, near Beaumont, *R. Crockett 7020* (LL, US); I-10, ca. 12 mi W of Orange, *J. Crutchfield 2540* (LL NY). **Panola Co.:** 18.4 mi NW on FR 31 from its jct. with Hwy. 84 in Logansport, La., *S. Jones & G. Jones 3677* (ARIZ); 0.7 mi NE of Sabine River and Hwy. 59, *W. Lewis & R. Oliver 5311* (SMU); 8 mi NE of Carthage, Sabine River bottoms, *L. Shinners 15654* (SMU). **Polk Co.:** 4.33 mi E of Corrigan, *V. Cory 22146* (GH); 5.5 mi W of Corrigan, *D. Correll & H. Correll 38962* (GH, LL, UC); jct. hwys. 1926 and 938, Big Sandy Section, Big Thicket National Preserve, *L. Dorr et al. 2184* (MO, NCU). **Red River Co.:** Lennox Woods Nature Preserve, 10 mi N of Clarksville on SH 37, 1.5 mi W along FM 2118 (to Mt. Pleasant community), and 1 mi S along county road, Pecan Bayou, 33.45 N, 95.05 W, *R. Sanders 1966* (BRIT, TEX); 16.5 mi N of Clarksville on Hwy. 37, *E. Whitehouse 20570* (SMU). **Robertson Co.:** Walnut Creek at SH 6, 30°22.21'N, 96°20.56'W, *D. Arrington & K. Winemiller BRA-07-26* (TAMU); seepage above Navasota River at Camp Cooley Ranch, *T. Starbuck 2233* (TAMU); US Hwy. 79 and Navasota River, *T. Starbuck 2404a* (TAMU). **Rusk Co.:** 0.5 mi W of jct. hwys. 322 and 149, S of Longview, *R. Mitchell 3173* (LL). **Sabine Co.:** 4 mi N of Hemphill, *V. Cory 22749* (GH). **San Augustin Co.:** ca. 6 mi NW of Denning, *D. Correll 27428* (LL). **San Jacinto Co.:** Rt. 150, ca. 4 mi W of Sheperd, *D. Correll & J. Crutchfield 30979* (GH, LL, UC); ca. 7 mi NNW of Cleveland on Tex. Hwy. 2025 in Sam Houston Natl. Forest, *J. Strother 201* (DS, SMU, TEX). **Shelby Co.:** 4.9 mi E on FM 139 at Chambers Creek Bayou from its jct. with FM 2427, *S. Jones et al. 1368* (TAES). **Smith Co.:** swamps, Big Sandy, *Reverchon 2031* (MO). **Titus Co.:** N of FM 127 NE of Monticello community, Blundell Creek area, *P. Amerson 906* (SMU); ca. 1.5 mi E of Monticello on Hwy. 127, 33°06'N, 95°05'W, *W. Mahler 6464* (SMU). **Trinity Co.:** Trinity, *Tharp 731* (US). **Tyler Co.:** E edge of Spurger, *D. Correll 27376* (LL, MO, NCU, SMU, UC); Town Bluff Lake, Neches River, E of Woodville, *D. Correll & E. Ogden 25146* (LL, MO, SMU). **Upshur Co.:** 8.5 mi N of Ore City, at Morris Co. line, *L. Shinners 18938* (SMU). **Van Zandt Co.:** Purtis Creek State Park, *W. Carr 9757* (TEX); 9 mi E of Edom (1.3 mi W of Neches River) on SR 64, *R. Van Vleet 532* (SMU); near Ocean Lake N of Edgewood, *E. Whitehouse 16456* (MICH, SMU). **Walker Co.:** Huntsville, *Tharp s.n.* (TEX). **Washington Co.:** Yegua Creek, *E. Brackett s.n.* (GH, TEX); without locale, *E. Brackett s.n.* (GH). **Wood Co.:** Little Sandy Club, Hawkins, *W. Mahler 9957* (BRIT); Quitman, *E. McMullen s.n.* (TEX); Lake Fork Creek and adjacent pond at Hwy. 182, 4 mi E of Quitman, *R. Mitchell 3906* (LL); Mineola, *J. Reverchon s.n.* (MO). **County undetermined:** Harrisburg, *J. Joor s.n.* (US).

Justicia longii Hilsenb., Pl. Syst. Evol. 169:231. 1990. (**Figs. 4F; 5G–I**). *Siphonoglossa longiflora* (Torr.) A. Gray, Syn. Fl. N. Amer. 2(1):328. 1878. *Adhatoda longiflora* Torr. in Emory, Rep. U.S. & Mex. Bound. Surv. 2(1):125. 1859, non *J. longiflora* Vis. (1839, 1840). TYPE: MEXICO. SONORA: road between Zuñi and Altar, Sep 1855, *A. Schott III no. 3* (*Mex. Bound. Surv. 726*) (HOLOTYPE: NY!; ISOTYPE: F!; probable ISOTYPE: US!).

Perennial herb to 3.5(–5) dm tall. Young stems subquadrate, multi-striate, evenly pubescent with retrorsely appressed eglandular trichomes 0.05–0.8 mm long. Leaves subsessile to petiolate; petioles to 10 mm long; blades linear-lanceolate to lanceolate to elliptic to ovate, 5–70 mm long, 2–12(–18) mm wide, 2–10 × longer than wide, (rounded to) acute to acuminate to subfalcate at apex, acute to subattenuate at base, surfaces puberulent with antrorse eglandular trichomes 0.05–0.8 mm long, trichomes sometimes becoming restricted to major veins on mature leaves. Inflorescence of axillary sessile to subsessile (i.e., borne on peduncles to 1 mm long) dichasia; dichasia opposite at distal leaf nodes, 1 per axil, 1–3-flowered. Bracteoles often subfoliose, linear to lance-elliptic, 4–24 mm long, 0.5–4.7 mm wide, abaxial surface pubescent like leaves; secondary bracteoles, if present, similar to bracteoles except smaller. Flowers sessile. Calyx 5-lobed, 4–9(–12) mm long, lobes linear to lance-elliptic, 3.5–8(–10.5) mm long, 0.7–2.1 mm wide, widest above and narrowed toward base, abaxially puberulent with antrorse eglandular trichomes 0.05 mm long. Corolla entirely white, 31–55 mm long,

externally pubescent with flexuose to retrorse eglandular trichomes 0.1–0.3 mm long, tube cylindric, 28–43 mm long, 1–1.5 mm in diameter near midpoint, upper lip 5–12 mm long, 2-lobed at apex, lobes rounded, 1 mm long, 1.2 mm wide, lower lip 6–13 mm long, lobes 4–12 mm long, 3–5.6 mm wide, apically rounded. Stamens 4–7 mm long, filaments glabrous; thecae 1.4–2 mm long (including spur), equal in size, parallel, unequally inserted (overlapping by 1 mm), both spurred at base, spurs to 0.3 mm long; pollen 3-aperturate, apertures flanked on each side by 2(–3) rows of insulae, exine reticulate. Style (23–)32–41 mm long, pubescent with eglandular trichomes; stigma 0.2–0.3 mm long, subhemispheric to ± equally 2-lobed. Capsule 6.5–10 mm long, glabrous, stipe 2.5–4 mm long, head ovoid to ellipsoid to subglobose, 6–6.5 mm long. Seeds 4, discoid, 2–2.5 mm long, 2–2.5 mm wide, surface and margin bubbly-tuberculate (covered with low, rounded, moundlike tubercles that do not or but barely overlap one another).

Phenology.—Flowering: unknown; fruiting: June.

Distribution and habitat.—Southwestern United States (Arizona, Texas) and northwestern Mexico (Sonora); Texas plants occur in a region of Chihuahuan desertscrub at elevations near 1515 m. In Texas the species is known only from the Chinati Mountains in Presidio County (Fig. 1), in the Basin and Range ecoregion of the Trans-Pecos. Both known collections were made in 1977.

The description above has been augmented with data from specimens collected outside of Texas. The Texan plants greatly resemble those from Arizona and Sonora (Daniel 2004), which are found in Sonoran desertscrub and thornscrub at elevations from 380 to 1360 meters. Other Acanthaceae that are disjunct between western Texas and Arizona/Sonora consist of *Carlowrightia arizonica* A. Gray and *Ruellia nudiflora* (Engelm. & A. Gray) Urb.

Morphologically similar species, and likely close relatives of *J. longii*, include *J. pilosella* and *J. masiaca* T.F. Daniel. The former species differs by the characters noted in the key above, and the latter differs by its corolla with a purplish limb and pollen that is 4-aperturate (Daniel 2004).

Daniel (2004) briefly discussed the typification of *Adhatoda longiflora*, but neglected to provide relevant details. Collection data on the type specimen from Torrey's herbarium at NY is complete and matches that in the protologue. The specimen is annotated in Torrey's hand with the name as published, "*Adhatoda ? longiflora*," and it includes attached drawings with floral details (that are included in Torrey's description) based on dissected flowers. This specimen was treated as the holotype by Hilsenbeck (1990) and Daniel (2004); however, Hilsenbeck annotated it as the lectotype in 1982. A duplicate of Schott's collection is extant at F, and a likely duplicate (bearing only the Boundary Survey number, "726") is at US; both collections were annotated by Hilsenbeck as isolectotypes. The specimen at F is mounted on a sheet with several other collections of this species made by Schott that lack correlation with accompanying labels. The label includes Schott's number, locality, and the year of collection, but does not bear Torrey's name or handwriting. It is not known to which of the various plants on the sheet this label pertains, however. The specimen at US lacks Torrey's name or handwriting; "Adhatoda *Torr*" is written on the Mexican Boundary Survey Label in a hand similar to, but not identical with that of Torrey. It appears that instead of two, or possibly three syntypes, the specimen at NY is the only one known to have been used by Torrey in preparing his protologue. It is thus treated as the holotype.

Texas specimens examined: **Presidio Co.**: lower San Antonio Canyon, S side of Chinati Mts., *M. Butterwick & E. Lott 3864b* (TEX); Chinati Mts., *M. Butterwick & E. Lott 3872* (TEX).

Justicia pacifica (Oerst.) Hemsl., Biol. Cent.-Amer., Bot. 2:515. 1882. (**Figs. 4E; 6A–C**). *Adhatoda pacifica* Oerst., Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1854. 164. 1855. Type: MEXICO. Oaxaca: Pacific Coast, Puerto de Santa Cruz, Oct 1842, *F. Liebmann 10687* (holotype: C!).

Justicia furcata Jacq., Pl. Rar. Hort. Schoenbr. 1:2, t. 3. 1797. nom. illegit. (non Lam. 1785, which appears to pertain to *Ruellia paniculata* L.). *Adhatoda furcata* (Jacq.) Nees in Alph. de Candolle, Prodr. 11:398. 1847. *Ecbolium furcatum* (Jacq.) Kuntze, Revis. Gen. Pl. 2:980. 1891.

Adhatoda furcata var. *terminalis* Nees in Alph. de Candolle, Prodr. 11:398. 1847. *Justicia furcata* Jacq. var. *terminalis* (Nees) Greenm., Publ. Field Columbian Mus., Bot. Ser. 2:262. 1907. Type: MEXICO: syntypes of Andrieux and Galeotti from Oaxaca, and Berlandier from the Valley of Mexico were cited.

Justicia caudata A. Gray, Proc. Amer. Acad. Arts 21:405. 1886. Type: MEXICO. Chihuahua: near Batopilas, Aug–Nov 1885, *E. Palmer 189* (holotype: GH!; isotypes: K!, US).

FIG. 6. Texas species of *Justicia*-II. A–C. *J. pacifica*. A. Habit (*Daniel 419* and *Hernández M. et al. 6371*). B. Inflorescence node (*Daniel 419* and *Hernández M. et al. 6371*) with one fertile bract partially removed on right, arrow indicates a sterile bract. C. Seed (*Daniel 9771*). D–F. *J. pilosella*. D. Habit (*Daniel 186*). E. Fertile node (*Daniel 186*) with one bracteole partially removed on left. F. Seed (*Reina G. & Van Devender 2003-864*). G–I. *J. wrightii* (*Turner & Turner 96-95*). G. Habit. H. Fertile node with one bracteole partially removed on right). I. Seed. Drawn by J. Weller.

Justicia runyonii Small, Addisonia 15:29. 1930. Type: U.S.A. Texas: Cameron Co.: near Brownsville, *R. Runyon s.n.*; collection from plants "grown in prop. house. #56095" (lectotype, designated here: NY!).

Reclining to erect perennial herbs to 1 m tall. Young stems subterete to subquadrate, multistriate, internodes mostly glabrous, nodes usually pubescent with antrorse to retrorse to antrorsely or retrorsely appressed eglandular trichomes 0.1–0.3 mm long, the trichomes sometimes extending several mm down the internode in 2 lines. Leaves petiolate, petioles to 4(–8) mm long, blades ovate to ovate-elliptic to narrowly elliptic to linear, 27–150 mm long, 2.6–43 mm wide, 2.5–19 × longer than wide, acuminate at apex, acute to attenuate at base, surfaces sparsely pubescent with antrorse to antrorsely appressed eglandular trichomes, martin entire to crenate, ciliate with trichomes like those on surfaces. Inflorescence of axillary and terminal dichasiate spikes (rarely of 1-flowered dichasia in leaf axils); axillary spikes sessile or borne on peduncles to 2 mm long, spikes (or 1-flowered dichasia) mostly opposite, 1–2 per axil, to 18 mm long (excluding corollas), rachis glabrous or sparsely pubescent with flexuose to antrorse eglandular trichomes 0.1 mm long, dichasia alternate, sessile, 1-flowered, bracts heteromorphic, subopposite to alternate, fertile bracts linear to lance-linear, 6–10 mm long, 0.9–1.5 mm wide, abaxial surface pubescent with antrorse to antrorsely appressed eglandular trichomes 0.1–0.2 mm long and distally with erect to flexuose glandular trichomes 0.1–0.2 mm long as well, sterile bracts smaller than fertile bracts, linear, 1–10 mm long, 0.1–0.7 mm wide, nearly glabrous or pubescent like fertile bracts; terminal spikes to 20 mm long, rachis pubescent like young stems, dichasia opposite, sessile, 1-flowered, bracts homomorphic, linear, 8–17 mm long, 0.7–1.5 mm wide, abaxial surface pubescent with antrorse to antrorsely appressed eglandular trichomes 0.1–0.2 mm long and distally often with flexuose glandular trichomes 0.05–0.2 mm long as well. Bracteoles linear, 4–9 mm long, 0.3–0.7 mm wide, pubescent like bracts. Flowers sessile. Calyx 5-lobed, 4–9 mm long, lobes lanceolate, 3.3–8 mm long, 1–1.6 mm wide, margin hyaline or lighter colored than central portion, abaxially glabrous or sparsely pubescent with antrorse eglandular trichomes 0.05 mm long. Corolla pinkish to violet with white markings on lower lip, 12–23 mm long, externally pubescent with erect to flexuose glandular (and sometimes eglandular as well) trichomes 0.1–0.2 mm long, tube 5–10 mm long, ampliate distally, upper lip 7.5–14 mm long, 2-lobed, lower lip 7–15 mm long, lobes 4–8 mm long, 3–6 mm wide. Stamens 6.5–12 mm long, filaments glabrous, thecae parallel, unequally inserted (overlapping by 0.5 mm), unequal in size (lower theca larger), 1.4–2.3 mm long (including basal appendage), glabrous or the upper theca dorsally pubescent with eglandular trichomes, lower theca with a basal appendage 0.05–0.3 mm long; pollen 2-aperturate, apertures flanked on each side by 2 rows of insulae, exine reticulate. Style 11–16 mm long, distally glabrous, proximally pubescent with eglandular trichomes, stigma 0.1 mm long, lobes not evident. Capsule 10–15 mm long, pubescent with erect to flexuose to retrorse eglandular trichomes 0.05–0.1 mm long, head ovoid to ellipsoid with a medial constriction, 7–9 mm long. Seeds 4, subspherical, 2.5–3 mm long, 2.3–2.9 mm wide, surfaces smooth, covered with deciduous trichomes to 0.05 mm long.

Phenology.—Flowering: July–December; fruiting: September–December.

Distribution and habitats.—United States (southern Texas), Mexico, Guatemala; Texas plants occur in thornscrub and evergreen woodlands, mostly on sandy soils at elevations from 4 to 21 m. In Texas, the species is limited to the Rio Grande Plains in the southernmost region of the state (Fig. 1). The occurrence of this species in Goliad County, well to the north of its other known occurrences (Wasshausen 1966; Turner et al. 2003; Poole et al. 2007), is based on a series of collections from an unspecified locale by E. F. Owens in 1940. These specimens indeed conform to the species, which has not been recollected in Goliad County since then.

In Texas this species has been known as *J. runyonii*. Small (1930) noted that it had evidently eluded botanists of the Mexican Boundary Survey and that the species had not been collected until 1922 when Robert Runyon found it on the banks of the Resaca Viejo, about five miles east of Brownsville. Small also noted its decorative potential, horticultural value, and drought tolerance. He indicated that it flowers sporadically, but following the autumn rains it blooms profusely.

On the label of one of his collections of this species, Runyon perceptively noted that this was "probably a Mexican specie[s] entering this region." I am convinced that he was correct in his speculation. Indeed, *J. runyonii* is indistinguishable from Mexican plants that have been associated with the following names: *J. furcata*

Jacq. (nom. illegit.; e.g., Sánchez S. 1979), *J. caudata* (Daniel 1995, 2004), and *J. pacifica*. All of these names pertain to plants as described above for Texan collections. While I suspect an older name that will apply to the North American plants lurks among West Indian or South American species in the little-studied *J. periplocifolia/sphaerosperma* complex, I herewith use the oldest legitimate name that has been applied to Mexican plants that correspond to *J. runyonii*, until such time as the taxonomy and nomenclature of the West Indian and South American species have been resolved.

In the protologue of *J. runyonii* Small discussed both wild plants from Texas and cultivated plants grown at the New York Botanical Garden, but he did not cite specific specimens. At NY, there is a specimen collected by Robert Runyon near Brownsville in Cameron County, and grown in a propagation house at the New York Botanical Garden. The specimen bears a date of 1925 (whether this refers to the collection in the field or collection of the cultivated plants remains uncertain) and was annotated as a probable holotype in 1982. A specimen from the Runyon Herbarium at LL was collected by Runyon (no. 569) on 20 October 1923 "in El Jardin tract about 5 miles from Brownsville, Texas." The specimen was identified by Small as *J. runyonii* at an unknown date. Both specimens are likely syntypes of *J. runyonii*, and the cultivated specimen at NY is designated as the lectotype above.

Additional Texas specimens examined: **Cameron Co.:** USFWS tract on E side of South Thompson Rd., 1.3 mi S of jct. F.M. 107 (1.9 air mi SE of jct. F.M. 107 and F.M. 506 at Santa Rosa, 26°14'N, 97°48'W, *W. Carr et al. 11572* (TEX); 4 mi E of La Paloma, *D. Correll & I. Johnston 17977* (LL); 2.5 mi NE of Olmito, *V. Cory 36473* (GH); Resaca del Rancho Viejo ("Old Cannon Resaca"), *I. Davis 53-593* (TEX); Lower Adams Tract, *I. Davis & M. Johnston s.n.* (TEX); Resaca at Olmito, *R. Fleetwood 11557* (SMU); Beaumont levee, 2.4 mi N of Lozano, *M. Johnston 2757* (SMU, TEX); Olmito, *J. Rose & P. Russell 24188* (US); El Jardin tract, ca. 5 mi from Brownsville, *R. Runyon 569* (LL, US); near Barreda, 13 mi N of Brownsville, *R. Runyon 3259* (TEX); near Barreda, *R. Runyon 3555* (TEX). **Goliad Co.:** without locale, *E. Owens 3149* (TAES), *3150* (TAES), *3151* (TAES). **Hidalgo Co.:** Methodist Camp Thicket S of Weslaco on Rt. 1015, just N of Llano Grande Lake, *B. Ertter & J. Larke 5232* (CAS, NY); Santa Ana Natl. Wildlife Refuge, S of Alamo, *R. Fleetwood 3166* (TEX). **Willacy Co.:** Yturria Ranch, ca. 0.8 mi NNE of Atwood windmill, ca. 2.3–2.4 mi SSE of Villareal Artesian Well, 26°35'13.8"N, 97°38'39"W, *W. Carr & S. Najera 26526* (TEX).

Justicia pilosella (Nees) Hilsenb., Pl. Syst. Evol. 169:225. 1990. (**Figs. 4C; 6D–F**). *Monechma pilosella* Nees in A. de Candolle, Prodr. 11:412. 1847. *Siphonoglossa pilosella* (Nees) Torr. in Emory, Rep. U.S. Mex. Bound. Surv. 2(1):124. 1859. TYPE: U.S.A. TEXAS: between Brazoria and San Felipe, 1835, *T. Drummond coll. 3, 255* (HOLOTYPE: K ex hb. Bentham; ISOTYPE: K ex hb. Hooker).

Adhatoda dipteracantha Nees in A. de Candolle, Prodr. 11:396. 1847. *Siphonoglossa dipteracantha* (Nees) A. Heller. Contr. Herb. Franklin & Marshall College 1:95. 1895. TYPE: MEXICO. TAMAULIPAS: ad Tampico de Tamaulipas, without date, *J. Berlandier 192* (LECTOTYPE, designated by Hilsenbeck, 1990: G-DC; presumed ISOLECTOTYPE: G-Moricand!).

Dipteracanthus procumbens Nees in A. de Candolle, Prodr. 11:133. 1847, invalid name (not accepted in original publication, see discussion below).

Siphonoglossa greggii Greenm. & C.H. Thomps., Ann. Missouri Bot. Gard. 1:409. 1914. TYPE: MEXICO. TAMAULIPAS: Matamoros, 7 Jun 1847, *J. Gregg 915* (HOLOTYPE: MO!).

Justicia turneri Hilsenb., Pl. Syst. Evol. 169:227. 1990. TYPE: U.S.A. TEXAS: Cameron Co.: vicinity of Brownsville, 10 m, 11 Jun 1941, *R. Runyon 2773* [cited as "2273" in protologue](HOLOTYPE: TEX!; ISOTYPE: US!).

Perennial herbs to 3.5 dm tall, sometimes trailing. Young stems subquadrate to quadrate with 4 longitudinal grooves, internodes 2-fariously pubescent with retrorse to retrorsely appressed eglandular trichomes 0.3–1 mm long and ± evenly pubescent with flexuose to flexuose-retrorse eglandular trichomes 0.5–1.3 mm long (latter trichomes sometimes sparse or absent) or internodes evenly pubescent with erect to flexuose to flexuose-retrorse eglandular trichomes 0.7–2 mm long. Leaves petiolate, petioles to 5 mm long, blades concolorous or discolorous, lance-ovate to ovate to narrowly or broadly elliptic, 9–53 mm long, 3.5–23 mm wide, 1.4–5.3 × longer than wide, rounded to acute at apex, (rounded to) acute at base, surfaces and margin pubescent (sometimes very sparsely so and/or with trichomes of surfaces restricted to midvein) with erect to flexuose to antrorse to antrorsely appressed eglandular (rarely also with scattered glandular) trichomes to 1.4 mm long, abaxial surface sometimes inconspicuously glandular punctate, margin entire to subsinuate. Inflorescence of sessile to subsessile dichasia in leaf axils, peduncles (if present) to 2 mm long; dichasia opposite or alternate, 1(–2) per axil, 1-flowered. Bracteoles subsessile to petiolate, oblanceolate to obovate to elliptic or subfoliose, 4–16 mm long, 1–5.5 mm wide, abaxial surface pubescent like leaves. Flowers sessile to subsessile (i.e., pedicels to 0.5 mm long). Calyx 5-lobed, 3.5–9 mm long, lobes subulate to lance-subulate, 2–7.6 mm long, 0.3–0.9

mm wide, usually widest at base, abaxially nearly glabrous or pubescent like bracteoles, margin ciliate. Corolla pinkish to light purplish with white markings on lower lip or entirely white, 12–30 mm long, externally pubescent with flexuose eglandular trichomes 0.05–0.4 mm long, tube cylindric, 8.5–19 mm long, 0.9–2 mm in diameter near midpoint, upper lip 3–9 mm long, 2-lobed at apex, lobes 0.5–1.2 mm long, lower lip 3–12 mm long, lobes 1.5–9 mm long, 1.5–5 mm wide. Stamens 3–7 mm long, filaments glabrous, thecae subparallel to subperpendicular, 0.7–1.6 mm long, subequal in length, glabrous, subequally to unequally inserted (overlapping by 0.5–1 mm), lower theca with an inconspicuous basal appendage 0.05–0.2 mm long; pollen 2-aperturate, apertures flanked on each side by 1–2 rows of insulae (sometimes incompletely formed or peninsulae), interapertural exine reticulate. Style 12–20 mm long, glabrous or sometimes pubescent near base with antrorse eglandular trichomes, stigma 0.1–0.2 mm long, equally to unequally 2-lobed or lobes not evident. Capsule 5–10 mm long, glabrous, head ovoid to ellipsoid, 4–6 mm long. Seeds 4, discoid, reddish or orangish turning dark brown when mature, 2.2–3.2 mm long, 2–3.3 mm wide, surface covered with low and rounded (± moundlike) non-overlapping tubercles.

Phenology.—Flowering: all year; fruiting: all year.

Distribution and habitats.—Southwestern United States (Texas and New Mexico) and Mexico (Chihuahua, Coahuila, Durango, Guanajuato, Hidalgo, Nuevo León, Puebla, Querétaro, San Luis Potosí, Tamaulipas, Zacatecas); in Texas plants occur mostly in association with limestone in arid and semi-arid regions of west-central, southern, and western regions of the state (Fig. 1) on rocky slopes, and along watercourses, roadsides, and fencerows in several biotic communities (e.g., Chihuahuan desertscrub, desert grassland, mesquite scrub, oak scrub, juniper woodland, oak-juniper woodland, oak woodland, pecan-cypress riparian forest) at elevations from 6 to 1660 m. The widespread species occurs in at least eight ecoregions of Texas, but is most abundant in the Rio Grande Plains, Stockton Plateau, Edwards Plateau, Basin and Range, and Rolling Plains.

Justicia turneri was previously known in Texan botanical literature as *Siphonoglossa greggii*, and distinguished from *J. pilosella* by its cauline pubescence consisting of retrorse trichomes disposed in decussating lines (vs. spreading and evenly disposed trichomes; e.g., Correll and Johnston 1970). Hilsenbeck (1990) indicated that the type of *S. greggii* pertained to *J. pilosella*, but that the species, as represented by paratypes, was distinctive. Thus, he described a new species, *J. turneri*, based on the paratypes and additional collections. Hilsenbeck (1990; key on p. 225) distinguished *Justicia turneri* from *J. pilosella* on the basis of the following attributes: stem hairs mostly 0.1–0.3 mm long (vs. "mostly 0.5–1.5 mm long") and disposed in two lines, leaves lanceolate to elliptic (vs. "rarely ovate, more often obovate to oblong") and strongly discolorate (vs. "not conspicuously discolorate"), corolla usually white (vs. purple or pink), anthers 0.9–1.3 mm long (vs. 1.5–2.2 mm long), and seeds 2.3 × 2.3 mm (vs. 3.3 × 3 mm). In spite of Hilsenbeck's efforts, these taxa have remained difficult to distinguish. Study of plants conforming to these taxa from northeastern Mexico also tend to "blur" the putative distinctions between them. Cauline pubescence (length, disposition, and shape) is particularly variable among both "typical" *J. pilosella* and among plants treated by Hilsenbeck (1990) as *J. turneri*. Indeed, most of the specimens annotated as *J. turneri* by Hilsenbeck have trichomes to 0.8 mm long; and sometimes these are either ± evenly disposed to concentrated in two lines. Leaf shape varies from lanceolate to elliptic among specimens treated as *J. turneri* and ovate to elliptic to obovate among those of *J. pilosella*. Surface discoloration of the leaves (dark adaxially and light abaxially) is prevalent among most, but not all, plants identified as *J. turneri*, but can also occur in plants of *J. pilosella*. *Stanford et al. 2139* (annotated by Hilsenbeck as *J. turneri*) from Tamaulipas does not show strong discoloration, but a plant from Querétaro (*Carranza G. 734*) that otherwise conforms to *J. pilosella* shows conspicuous foliar discoloration. Corolla color in plants identified as *J. turneri* by Hilsenbeck varies from white (some Texan plants) to pinkish to purplish (other Texan plants, but apparently more common in Nuevo León and Tamaulipas). In the protologue of *J. turneri* Hilsenbeck (1990) noted that flowers of the species were rarely lavender or pink. He discussed a form of the species from near Monterrey with both purple flowers and a "very densely hispid pubescence throughout." Richardson collected plants (*1406, 1407*) at Olmito Lake in Cameron County with pink corollas (with white stripes) and others with white corollas. Label data on *Runyon 3257* from the same locality noted the occurrence of plants with either white or

purple corollas there. Runyon also noted that seeds from white-flowered plants produced progeny with white corollas. In Hidalgo County, Ertter collected plants with leaves discolorate and lanceolate to elliptic, and with stems 2-fariously pubescent with retrorse trichomes to 0.6 mm long. Both white-flowered plants (*5230a*) and violet-flowered plants (*5230*) were encountered in this population. Anther thecae among specimens treated as *J. turneri* vary from 0.7–1.4 mm long, whereas those among specimens of *J. pilosella* vary from 1–1.6 mm long. Seed size among specimens treated as *J. turneri* varies from 2.2–2.8 × 2–2.9, whereas it varies from 2.5–3.2 × 2.5–3.3 among specimens of *J. pilosella*.

The considerable variation and overlap among the character states used by Hilsenbeck (1990) to distinguish these two taxa preclude recognition of *J. turneri* as a distinct species based on them. Other superficially similar, and likely closely related, species from northern Mexico appear to differ from *J. pilosella* in several characters. For example, *J. decurvata* Hilsenb., from Durango, differs by its linear to lance-linear leaves 2–4 mm wide and evenly puberulent young stems with trichomes to 0.3 mm long; and *J. hintoniorum* Nesom, from Nuevo León, differs by its corollas 31–35 mm long and capsules 10–11 mm long that are pubescent with eglandular trichomes.

Some plants of *J. pilosella* from southern Texas (e.g., *Daniel 191* at CAS and *Cory 51455* at CAS, both from Cameron County) and adjacent regions of Tamaulipas (e.g., *Daniel & Baker 3691* at CAS) and Nuevo León (*Daniel & Baker 3630* at CAS), have flexuose glandular trichomes on the bracteoles (and sometimes on adjacent leaves). These glands appear to be present on some (but not all) plants that have discolorate and lanceolate to ovate to elliptic leaves.

Hilsenbeck's (1990) lectotypification of the sole specimen ("Drummond ! coll. 3, n. 255, in h. Bentham") cited in the protologue of *Monechma pilosella* would appear to be unnecessary.

The name "*Dipteracanthus procumbens*" is treated as invalid for the following reason. Nees (1847) described "*Dipteracanthus procumbens*" as a new species on page 133 of de Candolle's *Prodromus*. There, he cited a single specimen: *Berlandier 192* from Tampico de Tamaulipas, Mexico, in Moricand's herbarium. On page 396 of the same work, Nees described *Adhatoda dipteracantha* as a new species based on 1) *Berlandier 192* from Tamaulipas as seen in the herbaria of de Candolle and Moricand, and 2) Drummond's "coll. 3 n. 250 in h. Hooker" from "Belio Bragosia et S. Felipe in prov. Texas." Under *A. dipteracantha*, he also cited as a synonym: "*Dipteracanthus procumbens* N. ab E.! in h. Moricand." Both pages were published simultaneously in 1847. Because "*Dipteracanthus procumbens*" was not accepted by the author in the original publication (i.e., he treated it both as the name of a new species and as a synonym for another name), according to Article 34.1 of the International Code of Botanical Nomenclature (McNeill et al. 2006) it is not validly published; however, *A. dipteracantha* is. Hilsenbeck (1990) designated *Berlandier 192* at G-DC as the lectotype of the latter name based on the microfiche of that specimen. Data on *Berlandier 192* at G-Moricand, a presumed isolectotype of *Adhatoda dipteracantha*, reveal that it was collected in 1827.

Representative Texas specimens examined: **Atascosa Co.:** 5.75 mi E of Pleasanton, *V. Cory 55364* (SMU, US). **Bexar Co.:** S of San Antonio, *E. Bogusch & M. Bogusch 4705* (F); 11 mi N of San Antonio, *M. Clare 86* (CAS, MICH); San Antonio, *J. Clemens & Clemens 1061* (CAS, DS, MO); near Bracken, *B. Groth 79* (F); Comanche Springs, New Braunfels, *F. Lindheimer 1065* (F, P, UC, US). **Blanco Co.:** Edwards Plateau, Pedernales River near Pedernales Falls, ca. 30°20'N, 98°15'W, *T. Daniel & M. Butterwick 8962* (CAS); Pedernales Falls State Park, *B. Ertter et al. 4879* (CAS). **Brewster Co.:** Hwy. 385, 12.1 mi S of jct. Hwy. 385 and Hwy. 90, *T. Daniel 115* (CAS); 10 mi E of Alpine, *C. Rowell 11542* (SMU, UC); Hwy. 223, ca. 1 mi N of Alpine, *O. Sperry T1055* (UC); ca. 11 mi S of Marathon, *O. Sperry 1560* (UC); ca. 16 mi E of Alpine, *B. Warnock 571* (TEX, UC). **Brown Co.:** Brownwood, *E. Palmer 26803* (MO); Brownwood, *H. Purvis 3* (LL, SMU). **Burnet Co.:** Mormon Hole near Mormon Mills, Hamilton Creek, *D. Correll & H. Correll 12719* (SMU); along Colorado River, *S. Wolff 3214* (US). **Callahan Co.:** Baird, *G. [illegible] 29* (MO), *389* (F); ca. 3 mi W of Putnam on US Hwy. 80, *N. Henderson 62-779* (SMU); Baird, *J. Reverchon 728* (F). **Cameron Co.:** Rio Hondo, *H. Chandler 7081* (MO); Arroyo Colorado, Harlingen, *D. Correll 28966* (LL, MO, US); Arroyo Colorado, just E of Harlingen, *D. Correll & I. Johnston 17901* (LL, MO, SMU); 4 mi E of La Paloma, *D. Correll & I. Johnston 17974* (LL); Resaca del Rancho Viejo, 0.5 mi SW of Olmito, *V. Cory 51455* (DS, GH, SMU, TEX, US); Camp Perry (Boy Scout Camp) near Hwy. 1420, 2.9 mi S of Willacy Co. line, *T. Daniel 191* (CAS, MICH); near Resaca del Rancho Viejo, NE of Brownsville, *N. Hotchkiss 6145* (US); near Port Isabel, *C. Lundell & A. Lundell 8659* (LL, MICH, SMU, US); Olmito Lake, Olmito, *A. Richardson 1406* (TEX), *1407* (TEX); Olmito, *J. Rose & P. Russell 24187b* (US), *24189* (US); La Feria, *R. Runyon 63* (TEX, US); Brownsville, *R. Runyon 370* (TEX), *422* (TEX); Loma near coast, *R. Runyon 1445* (TEX, US); Olmito Lake, *R. Runyon 3257* (TEX); Barreda Station, *R. Runyon 5188* (TEX); Arroyo Colorado, Harlingen, *R. Runyon 5191* (TEX); Green Island, *B. Tharp 1211* (TEX, US). **Coke Co.:** Rancho Escondido, 0.2 mi NW of main entrance, near Wildcat Creek, UTM 3512 35227, *L. Sanchez 4341* (TEX). **Comal Co.:**

New Braunfels, *F. Lindheimer 396* (MO, SMU), *505* (MO), *H. Ripley & R. Barneby 4155* (CAS); near the Guadalupe River, *R. Wagoner & F. Barkley 13802* (MO, TEX, UC). **Crockett Co.:** Hwy. 163, 18.2 mi N jct. Hwy. 163 and Hwy. 189 (east branch), *T. Daniel 121* (CAS); rocky shades, *J. Reverchon 728* (DS, F, MICH, MO, SMU, US). **Dewitt Co.:** Cuero, *B. Tharp 2664* (TEX). **Dimmit Co.:** Chaparral Wildlife Management Area, near research buildings, *D. Goldman 1853* (MO). **Duval Co.:** San Diego, *M. Croft s.n.* in 1885 (MICH); 6.7 mi SE of Freer, *L. Shinners 19617* (SMU); 3 mi E of Bruni on SH 359, *M. Solis 34* (SMU). **Edwards Co.:** Hwy. 55, 18.4 mi S jct. Hwy. 55 and Hwy. 377 South in Rocksprings, *T. Daniel 197* (ASU, CAS). **Frio Co.:** 5 mi N of Pearsall, rest area, *J. Taylor & B. Lipscomb 31779* (BRIT). **Gillespie Co.:** Threadgill, *G. Jermy 448* (US); LBJ National Historic Park, Pedernales River near Ranch House, 30°15'N, 98°37'W, *R. Sanders 5308* (BRIT). **Goliad Co.:** McNamara Ranch, 0.2 mi NE FM 1351, SE side Hwy. 59, *S. Hill 6146* (NY). **Gonzales Co.:** near Gonzales, *J. Drushel 8344* (MO, US). **Guadalupe Co.:** 4.2 mi NE of New Berlin on Farm Road 775, *M. Johnston & W. McCart 5099* (SMU). **Hays Co.:** San Marcos, *F. Pennell 10435* (NY); San Marcos, *Trelease s.n.* (MO). **Hidalgo Co.:** Mission, *I. Chateau s.n.* (F); Santa Ana Wildlife Refuge, *D. Correll & C. Schweinfurth 15619* (LL); West Lake, Santa Ana Wildlife Refuge, *D. Correll & D. Wasshausen 27690* (LL, US); Methodist Camp Thicket S of Weslaco on Rt. 1015, just N of Llano Grande Lake, *B. Ertter et al. 5230* (CAS, TEX), *5230a* (CAS, NY); Santa Ana Wildlife Refuge, Alamo, *R. Fleetwood 30* (US); La Joya, *R. Runyon 2850* (TEX, US); North Edinburg, *I. Schillerr 868* (US); McAllen, *E. Schulz 2862* (F). **Irion Co.:** 3.1 mi SSW of Mertzon, *L. Shinners 31487* (SMU). **Jackson Co.:** 3 mi SE of Vanderbilt, Red Fish Bayou, *B. Turner et al. 3308* (TEX). **Jeff Davis Co.:** Mt. Livermore, *L. Hinckley 634* (F); Limpia Canyon, 11 mi NE of Fort Davis on Hwy. 17, *C. Lundell & A. Lundell 13131* (SMU); Davis Mt. State Park, Davis Mts., 7.4 km W of Fort Davis on TEX 118, 30°36'N, 103°56'W, *A. Reina & T. Van Devender 2003-864* (CAS); Davis Mts., *S. Tracy & F. Earle 351* (US). **Jim Hogg Co.:** Farm Rd. 649, Vela Pena Ranch, 20 mi S of Miranda City, *R. Sanchez et al. 8314* (TEX). **Jim Wells Co.:** N of Alice, *C. Albers 46370* (TEX, UC); 4 mi W of Alice, *L. Shinners 19578* (SMU). **Karnes Co.:** 1.5 mi SE of Falls City on US Hwy. 181, *J. Johnson 1029* (US). **Kendall Co.:** 14 km (air) NNE of Boerne, Camp Alzafar, vic. Guadalupe River, *C. Lieb 560* (NY). **Kenedy Co.:** King Ranch (Norias Division), Portales #3 B.M., Laguna Madre coast in Saltillo Pasture, *M. Johnston 53266.2* (TEX); King Ranch, Norias Division, *C. Lundell & D. Correll 15129* (LL, MO, SMU, UC, US). **Kimble Co.:** South Llano River at Schreimer Park in Junction, ca. 30°30'N, 99°46'W, *T. Daniel & M. Butterwick 9999* (CAS). **Kinney Co.:** Fort Clark, *E. Mearns 1454* (DS, US); Anacacho Mts., ca. 30 mi SE of Brackettville, *J. Strother 249* (DS, SMU). **Kleberg Co.:** Kingsville, *E. Bogusch 11911* (UC); San Fernando Creek NE of Kingsville, *D. Correll & C. Schweinfurth 15602* (LL, SMU, UC); S end of Canelo Pasture, Santa Gertrudis Division of King Ranch, *M. Johnston 5423* (SMU, TEX); Kingsville, *J. Sinclair s.n.* (TEX). **La Salle Co.:** 8 mi W of Artesia Wells, Chaparral Wildlife Management Area, *D. Seigler et al. 15107* (TEX). **Live Oak Co.:** Rte. 281 S of George West, 11.1 mi N of FM 3162, *S. Hill 18258* (MO). **Llano Co.:** Llano, *W. Bray 309* (TEX, US). **Mason Co.:** Loyal Valley, *E. Dapprich 7423* (SMU). **Maverick Co.:** 18 mi E of Eagle Pass, *D. Correll & D. Wasshausen 27722* (LL, UC, US); 7.7 mi SE of jct. hwys. 277 and 693, *T. Daniel 183* (CAS); 5 mi N of Normandy *SCORA 2292* (US). **Medina Co.:** 19 mi N of Hondo along Hondo Creek, *D. Correll et al. 28218* (LL, US). **Menard Co.:** John Royal Ranch, 19 mi SE of Menard, *F. Gould 5718* (SMU). **McMullen Co.:** 2 mi N of Fowlerton on SH 72, *F. Gongora et al. 8524* (SMU). **Mills Co.:** 8.5 mi SW of Goldthwaite on Hwy. 16, *V. Cory 58205* (SMU); rest stop on state hwy. 16, ca. 1.1 mi N of Colorado River, *J. Taylor & C. Taylor 33703* (BRIT). **Nueces Co.:** 9 mi NW of Corpus Christi, *V. Cory 20586* (GH); Corpus Christi, *A. Heller 1425* (US); Corpus Christi, *E. Virden s.n.* (Sept 1860) (MO). **Palopinto Co.:** Strawn, *E. Palmer 14252* (MO). **Pecos Co.:** Pecos River bottoms near Sheffield, *R. Ferris & C. Duncan 2885* (CAS, DS, MO); Mesquite Valley and Florueusia Valley, *B. Tharp 43-856* (TEX, UC), *43-857* (MO, TEX); 2 mi SE of Longfellow Ranch (40 mi E of Marathon), 30°09'N, 102°37'W, *G. Webster & B. Westlund 32516* (DAV). **Presidio Co.:** Big Bend Ranch State Park, W side of The Solitario, ca. 29°27'N, 103°51'W, *T. Daniel & M. Butterwick 8433* (CAS); Chinati Mts. State Natural Area, Pekillos Arroyo on SW side of Chinati Mts., 29°51.5'N, 104°29'W, *E. Lott & S. Rankin 4958* (CAS, TEX). **Reagan Co.:** along Hwy. 67 just before it enters Upton Co., 31°18'N, 101°46'30"W, *B. Turner 20-157* (LL). **Refugio Co.:** Austwell, *B. Tharp s.n.* (TEX). **San Patricio Co.:** 7 mi S of Taft, *F. Jones 398* (SMU). **San Saba Co.:** Chappel, *B. Barnette 248* (SMU); San Saba, *E. Palmer 11833* (MO, TEX). **Starr Co.:** W of Sullivan City on US Hwy. 83, *C. Lundell & A. Lundell 9898* (MICH, SMU); Rio Grande City, *Nealley 4359* (F); 3 mi N of Roma, *L. Shinners 17713* (SMU). **Stephens Co.:** Caddo, *A. Ruth 1303* (US); 13.5 mi NNW of Breckenridge, *L. Shinners 30336* (SMU). **Sterling Co.:** edge of Concho River, 4 mi SW of Sterling City, *J. Crutchfield 1842* (LL, NY). **Sutton Co.:** Hwy. 277, 11.8 mi S jct. Hwy. 277 and Hwy. 290 in Sonora, *T. Daniel 200* (CAS). **Taylor Co.:** near Cedar Creek, N of Hwy. 20 on N side of Abilene, *W. Mahler 3740* (MO, SMU); near Camp Barkeley, *W. Tolstead 7121* (TEX, UC); at Camp Barkeley, *W. Tolstead 7137* (MICH, MO). **Terrell Co.:** 4 mi E of Sanderson, *C. Hitchcock & L. Stanford 6824* (DS, UC); Sanderson, *C. Orcutt 724* (DS); Sanderson Canyon, 14 mi E of Sanderson on Hwy. 90, *E. Whitehouse 18615* (SMU). **Throckmorton Co.:** Clear Fork of the Brazos River, ca. 11 km W and 16 km S of Throckmorton, John Matthews Ranch, *J. Cornelius 1072* (BRIT). **Tom Green Co.:** San Angelo, *J. Reverchon s.n.* (5-20-1907) (MO); Knickerbocker Ranch, Dove Creek, *F. Tweedy 280* (US). **Travis Co.:** Barton Springs Creek, *F. Barkley s.n.* (TEX, UC); Mount Bonnell, vicinity of Austin, *L. Taylor 3188* (UC); Austin, *B. Tharp s.n.* (UC). **Upton Co.:** along Hwy. 67 just before it enters Reagan Co., 31°18'N, 101°47'W, *B. Turner 20-141* (LL). **Uvalde Co.:** Nueces River on Hwy. 55 just SE of Laguna, NW of Uvalde, *B. Ertter 5374* (CAS, TEX); W of Uvalde, *M. Ferguson & A. Ottley 4367* (UC); Sabinal, *E. Palmer 10113* (DS, MO, US); Neal's Camp on Frio River, ca. 60 km N of Uvalde on TX 127 near Cancon, 29°30'N, 99°43'W, *A. Reina & T. Van Devender 2003-816* (CAS); ca. 5 mi E of Uvalde, *S. Solymosy S090569116* (SMU); Hondo, *B. Tharp s.n.* (CAS). **Val Verde Co.:** Hwy. 163, 5.9 mi N jct. Hwy. 163 and Hwy. 189 (east branch), *T. Daniel 123* (CAS); Del Rio, *M. Jones 26213* (DS, MO ["26218"], US); along Devil's River at Fawcett Lodge, 20–30 mi upriver, *B. Warnock 11291* (LL, SMU); Tres Niños Ramcj. ca. 9 mi NW of Pandale, 30°15.5'N, 101°41'W, *G. Webster et al. 33037* (DAV). **Webb Co.:** Pan American Courts Motel lawn, W of I-35, N of Laredo, *T. Daniel 258* (CAS); Bruni, *R. Lopez 100* (SMU); near Laredo, *K. Mackenzie 31* (MO); Laredo, *C. Orcutt 5703* (MO). **Willacy Co.:** between Raymondville and Red Fish Bay, *E. Clover 1266* (MICH, NY); Sauz Ranch, ca. 2 mi SW of headquarters, *L. Davis & M. Johnston 53266.4* (TEX). **Wilson Co.:** Southerland Springs, *E. Palmer 9198* (DS, MO, US), *9299* (DS, MO, US). **Zapata Co.:** Arroyo Veleno on Hwy. 16, 8.2 mi NE of jct. Hwy. 16 and Hwy. 83 in Zapata, *T. Daniel 186* (CAS). **County undetermined**: Reficillos, *V. Harvard s.n.* (US);

Justicia warnockii B.L. Turner, Field & Lab. 19:100. 1951. (**Figs. 4D; 5J–L**). TYPE: U.S.A. TEXAS: Brewster Co.: slope one-third way up Old Blue, Glass Mountains, 5000 ft, 2 Jun 1941, *B. Warnock W325* (HOLOTYPE: TEX!; ISOTYPES: DS!, F!, GH!, LA!, MO!, NCU!, NY!, PH!, POM!, S!, SRSC!, UC!).

Erect, basally branched, broomlike to globose suffrutescent perennial herbs to 4 dm tall. Younger stems green, striate, pubescent in 2 vertical decussate lines (or with pubescence ± diffuse or very inconspicuous) with recurved eglandular trichomes 0.05–0.2 mm long (strigillose). Leaves sessile, strongly ascendant, (acicular to) linear to narrowly oblanceolate (to obspatulate near base of plant), 2.5–25 mm long, 0.4–1.3(–2) mm wide, 6–18 x longer than wide, acute at apex, narrowed to base, surfaces glabrous, margin flat to somewhat revolute, glabrous. Inflorescence of dichasia in leaf axils or in axils of reduced leaves or bracts along distal portion of stem forming a spicate axis to 8 cm long; dichasia alternate, sessile, 1-flowered. Bracteoles linear-subulate to filiform, 1.5–4.5 mm long, 0.2–0.4 mm wide, glabrous. Flowers sessile to subsessile (i.e., with pedicels to 0.3 mm long). Calyx deeply 4-lobed, 1.5–4 mm long, lobes subulate, 1–3.5 mm long, 0.1–0.2 mm wide, abaxially glabrous. Corolla whitish or lavender with maroon to purplish markings in throat, 7–13.5 mm long, externally pubescent with erect to retrorse eglandular trichomes 0.05–0.2 mm long, tube 4.5–6 mm long, distally gradually expanded to mouth, upper lip ± erect, 4–6.5 mm long, emarginate to 2-lobed, lower lip 5–7 mm long, lobes not strongly revolute, 2–4 mm long, 1.2–3 mm wide, central lobe larger than lateral lobes. Stamens 3.5 mm long, filaments glabrous, thecae maroon, 0.5–0.8 mm long, parallel to subparallel, subequal in size (lower slightly longer), unequally inserted (overlapping by 0.5 mm), glabrous, lower theca with a basal spur 0.1–0.2 mm long; pollen 4-aperturate (4-pororate, lacking insulae and pseudocolpi), exine reticulate. Style 5–7 mm long, glabrous; stigma ± capitate, 0.2 mm long. Capsules stipitate, 5.5–8 mm long, glabrous (rarely minutely and inconspicuously pubescent at apex with eglandular trichomes to 0.05 mm long), stipe 2–3.2 mm long, head ellipsoid, lacking a medial constriction, 3.5–5 mm long, 2.5–3 mm wide. Seeds 4 per capsule, discoid, 2–2.5 mm long, 1.8–2.5 mm wide, surfaces minutely granulate, glabrous (or glandular), margin differentiated from remainder of seed surface (i.e., distinct peripheral band present), fringed with glandular trichomes up to 0.1 mm long.

Phenology.—Flowering: April (cleistogamous only), June–September; fruiting: May–December.

Distribution and habitats.—Southwestern United States (Texas) and north-central Mexico (Chihuahua, Coahuila); Texas plants occur on limestone slopes and arroyos in Chihuahuan desertscrub and mesquite-juniper brush at elevations from 545 to 1400 meters. In Texas the species is limited to the Stockton Plateau and the Basin and Range ecoregions in the arid western portion of the state (Fig. 1).

Justicia warnockii is endemic to the northern Chihuahuan Desert region, and it appears to be related to several other species endemic to this region (see under *J. wrightii* below). Plants typically have numerous, dense, thin, and wispy stems that give them a broom- or brushlike appearance. *Daniel & Butterwick 8431*, collected in April, contains old stems with persisting fruits from the previous season and new growth bearing a few cleistogamous flowers 1.5–2.5 mm long; chasmogamous flowers appear later in the season.

Additional Texas specimens examined: **Brewster Co.:** summit of Bullis Range S of Bullis Gap on Bullis Gap Ranch, *M. Butterwick & E. Lott 3583* (TEX); Black Gap Wildlife Refuge, lower Maravillas Canyon, *D. Correll & H. Correll 30661* (CAS, LL); near mouth of Heath Canyon, *D. Correll 31564* (LL); Reagan Canyon, 3 mi from Rio Grande, *L. Hinckley & B. Warnock 461097* (MO, RSA, S, TEX, UC, US); Packsaddle Mountain, 65 mi S of Alpine, *G. McKenzie 307* (SMU); Black Gap Wildlife Management Area, Frog Canyon, ca. 35 mi SSE of Marathon, *C. Rowell 5131* (DAV, SMU), *11612* (UNM); head of Brushy Canyon just below E side of Sue Peak, 29°25'N, 102°56'W, *B. Turner 22-149* (TEX); W of Rio Grande Village, Big Bend Natl. Park, *T. Van Devender & V. Cohen s.n.* (CAS); Black Gap Wildlife Refuge, Maravillas Canyon, 8.6 mi from headquarters, *T. Van Devender & L. Toolin s.n.* (CAS); Shackleford Ranch, head of Brushy Canyon, E side of Sue Peaks, 29°25'N, 102°56'W, *B. Turner & B. Dodson 23-278* (CAS); slopes of Old Blue, Glass Mountains, *B. Warnock 325* (GH-collected on different date from type); Old Blue, Glass Mts., *B. Warnock 9039* (LL, SMU); near McKinney Springs, Dead Horse Mts., Big Bend Natl. Park, *B. Warnock 10786* (LL, SMU); S of Ward Spring, W side of Chisos Mts., Big Bend Natl. Park, *B. Warnock 13007* (LL); Black Gap Refuge, upper Big Brushy Canyon of Dead Horse Mts., 95 mi S of Alpine, *B. Warnock & L. Hinckley BG-137* (LL, SMU); Reagan Canyon, *B. Warnock & L. Hinckley 3742* (NY, US). **Crockett Co.:** bluff of Pecos River, above its jct. with Independence Creek, *G. Webster 492* (MICH, TEX). **Hudspeth Co.:** below and E of Deer Peak, south-west of Quitman Mts., *A. Powell et al. 2901* (LL); Mayfield Canyon, S of Quitman Mts., near Rio Grande, *A. Powell et al. 2928* (LL); Quitman Mts., S of Sierra Blanca, *B. Warnock et al. 18061* (SRSC). **Pecos Co.:** main canyon on NE side of Sierra Madre, ca. 25 mi S of Fort Stockton, *R. McVaugh 10654* (DS, DUKE, ENCB, LL, MICH, MO, NY, PH, SRSC, UC, US); mesa margins, *B. Tharp 43-854* (MO, NY, PH, TEX, UC, US).

Presidio Co.: Big Bend Ranch State Park, W side of The Solitario, ca. 1.5 km NW of Solitario Peak, ca. 29°28'N, 103°51'W, *T. Daniel & M. Butterwick 8431* (CAS); 0.25 mi N of Solitario Peak, 29°28'N, 103°50'W, *M. Johnston 3430* (NY, US). **Terrell Co.:** along Rio Grande between Reagan Canyon and Sanderson Canyon, *B. Warnock 15855* (MO, SRSC).

Justicia wrightii A. Gray, Syn. Fl. N. Amer. 2:329. 1878. (**Fig. 6G–I**). *Ecbolium wrightii* (A. Gray) Kuntze, Revis. Gen. Pl. 2:981. 1891. Type: U.S.A. Texas: western Texas to El Paso, New Mexico, May–Oct 1849 (fide label); Val Verde Co.: calcareous hills of San Felipe, 7 Jul 1849 (fide field notes), *C. Wright 445* (holotype: GH!; possible isotypes: GH!, US!).

Erect perennial herbs to 2 dm tall from a stout woody caudex. Younger stems subquadrate to ridge-angled, sometimes multistriate with ridges brownish and grooves green, ± evenly and sparsely to very sparsely pubescent with retrorse to retrorsely appressed (to antrorse) eglandular trichomes 0.05–0.2 mm long. Leaves sessile to subsessile, petioles (if present to 1 mm long), blades linear to elliptic to obovate to oblanceolate, 4–15 mm long, 1–4 mm wide, 2.2–8.6 × longer than wide, usually reduced in size acropetally, acute to rounded at apex, tapered to base, surfaces pubescent with cauline type trichomes or with trichomes mostly restricted to margin, margin flat. Inflorescence of dichasia in axils of leaves; dichasia alternate, 1-flowered, 1 per axil, sessile. Bracteoles linear-subulate to linear to oblanceolate, 2.5–11 mm long, 0.5–2 mm wide, pubescent with mostly retrorse to retrorsely appressed eglandular trichomes 0.05–0.2 mm long. Flowers sessile. Calyx 4-lobed, 2.3–5 mm long, lobes subulate, equal, 2–4.5 mm long, 0.4–0.6 mm wide, pubescent like bracteoles or with the trichomes becoming antrorse to antrorsely appressed. Corolla "purplish" (in dried state: light colored and tinged with maroon and with maroon markings on lower lip), 8–12 mm long, externally pubescent with erect to flexuose eglandular trichomes 0.1–0.2 mm long, tube ± gradually expanded distally, 3–3.5 mm long, 1.6 mm in diameter near midpoint, upper lip 4–6.5 mm long, apically 2-lobed, lobes 0.3–0.7 mm long, lower lip 4–6 mm long, lobes 3–4 mm long, 1.5–3.5 mm wide, central lobes larger than lateral lobes. Stamens inserted in distal half of corolla tube, 2.5–5 mm long, filaments glabrous, thecae 0.5–1.3 mm long (including basal appendage), unequal (upper theca 0.5–0.9 mm long and lower theca 0.8–1.3 mm long), subparallel to subperpendicular, unequally inserted (overlapping by 0.3 mm), upper theca dorsally pubescent with eglandular trichomes, lower theca glabrous, with a basal spurlike appendage 0.1–0.3 mm long; pollen 4-aperturate (4-colporate, lacking insulae and pseudocolpi), exine reticulate. Style 4.5–6 mm long, glabrous or pubescent with eglandular trichomes proximally, stigma 0.2–0.3 mm long, minutely 2-lobed. Capsule 7–8.5 mm long, glabrous or sparsely pubescent at apex with eglandular trichomes 0.1 mm long, stipe 1.5–2 mm long, head ellipsoid, 5.5–6.5 mm long. Seeds 4, discoid, 2.5–3.5 mm long, 2.5–3.6 mm wide, surfaces smooth to reticulate, pubescent with apically barbed trichomes (sometimes ± restricted to margin) 0.05–0.2 mm long, marginal region undifferentiated to ± differentiated (becoming less so at maturity) from remainder of seed.

Phenology.—Flowering: April–August; fruiting: April–July.

Distribution and habitats.—Endemic to the southwestern United States (New Mexico and Texas); Texas plants occur on rocky calcareous soils in Chihuahuan desertscrub and semi-arid scrubland at elevations from 300 to 1455 meters in the Basin and Range and Stockton Plateau ecoregions (i.e., in and adjacent to the eastern edges of the Chihuahuan Desert; Fig. 1).

Although this species likely occurs in adjacent regions of Mexico, it remains documented only from north of the Rio Grande where it is a rare species based on both low numbers of individuals and a limited distribution. Based on the fewer than twenty known global occurrences of *Justicia wrightii*, it has a global rank of G2 and a state rank (for Texas) of S2 (based on the Nature Conservancy ranking system; cf. Poole et al. 2007). These rankings denote that the species is imperiled both globally and in Texas because of rarity and is very vulnerable to extinction throughout its range or extirpation from Texas. Poole et al. (2007) reported possible occurrences in Brewster and Terrell counties, but no specimens of the species from those counties have been located. A specimen from Castolon in Brewster County (*Parks & Cory s.n.* at TAES) that was identified as *J. wrightii* and recorded as such by the Texas Natural Heritage Program appears to pertain instead to *Carlowrightia linearifolia* (Torr.) A. Gray. The most recent collection of *J. wrightii* from Texas was made in 1996 in Pecos County.

Based on morphological similarities the closest relatives of *Justicia wrightii* are the Chihuahuan Desert

endemics *J. henricksonii* T.F. Daniel and *J. warnockii* (Daniel 1980). Although pollen of *J. henricksonii* has not been studied, pollen of both *J. wrightii* and *J. warnockii* differs from other species of *Justicia* in the Chihuahuan Desert and the United States by having four (vs. two or three; cf. figs. 2 and 3) apertures. Four-aperturate pollen is known among other species of *Justicia* elsewhere in Mexico (Daniel 1998). The description above includes data from plants collected in New Mexico.

Additional Texas specimens examined: **Pecos Co.:** ca. 19 mi E of Ft. Stockton along IH-10, just W of roadside park, *B. Turner & G. Turner 96-95* (TEX); 40–45 mi SE of Ft. Stockton toward Sanderson, *B. Warnock 13438* (LL); hwy. to McCamey, 20 mi N of Ft. Stockton, *B. Warnock 46181* (TEX); 22 mi S of Ft. Stockton, *B. Warnock & R. McVaugh 8707* (LL, SMU, SRSC). **Val Verde Co.:** Del Rio, *M. Jones 26216* (POM); between Del Rio and Loma Alto, *B. Warnock 11204* (LL, SMU); ca. 3 mi W of Del Rio, *B. Warnock 11319* (LL, SMU).

APPENDIX 1

Species of *Justicia* cultivated out-of-doors in Texas

Collections from plants cultivated out-of-doors in Texas have been documented for the six species of *Justicia* listed below. These species may sometimes persist following cultivation, and have potential to become naturalized. A brief description, with diagnostic characters of each, is provided to permit their identification. Other species that have been observed in greenhouses of botanical gardens in the state include: *J. aurea* Schltdl., *J. betonica* L., *J. californica* (Benth.) D.N. Gibson, *J. candicans* (Nees) L.D. Benson, *J. extensa* T. Anders., *J. gendarusa* Burm.f., and *J. scheidweileri* V.A.W. Graham.

1. **Justicia adhatoda** L. (Malabar nut, basaka, adulsa)
Shrubs to 3 (or more) m tall; inflorescence of axillary, pedunculate, and elongate spikes; bracts green, ovate elliptic to elliptic, 14–25 mm long; corolla white with maroon markings on lower lip, 25–30 mm long; anthers green. Native to Asia.

Cameron Co.: *R. Runyon 5440* (TEX).

2. **Justicia brandegeana** Wassh. & L.B. Sm. (shrimp plant). Perennial herbs to shrubs to 1 m (or more) tall, branches weak or drooping; inflorescence drooping or nodding; bracts maroon-tinged (sometimes merely yellowish green), broadly ovate to ovate, apex not spreading, rounded to cordate at base; bracteoles ovate to elliptic, 3–6.5 mm wide; corolla white (to yellowish) with maroon or reddish markings within. Native to Mexico. Selections and/or hybrids (e.g., "fruit cocktail") involving this species have resulted in numerous forms with variously colored bracts and corollas, and with erect inflorescences.

Hidalgo Co.: *C. Lundell & A. Lundell 12776* (GH, LL, MICH, US). **Galveston Co.:** *F. Waller & J. Bauml 3526* (TEX). **Harris Co.:** *A. Traverse 1395* (LL). **Travis Co.:** *J. Wiedenhoff 21* (TEX).

3. **Justicia carnea** Lindl. (Brazilian plume)
Perennial herbs or shrubs to 3 m tall; inflorescence of terminal, dense, headlike clusters; bracts conspicuous, green to very dark maroon; corolla pink (or white), 50–65 mm long; anthers pink to maroon. Native to southern South America. All of the corollas tend to open at the same time, resulting in a dramatic display. A form with white flowers is sometimes cultivated, but the pink-flowered form is more common.

Bexar Co.: *H. Parks s.n.* (GH). **Harris Co.:** *A. Traverse 2408* (BRIT).

4. **Justicia fulvicoma** Schltdl. & Cham. (Mexican plume, orange shrimp plant)
Perennial herbs or shrubs to 1 m (or more) tall, branches stout and erect; inflorescence erect; bracts maroon-tinged, lanceolate to ovate to elliptic, apex recurved-spreading, rounded to acute at base; bracteoles lanceolate to linear, 0.9–2 mm wide; corolla orange and usually with reddish markings within. Native to Mexico.

Bexar Co.: *T. Daniel 6295* (CAS). **Sutton Co.:** *V. Cory s.n.* (GH). **Kleberg Co.:** *E. McClane s.n.* (GH).

5. **Justicia leonardii** Wassh. (orange justicia, summer sun justicia)
Shrubs to 1 m tall; stems and leaves not yielding a bluish dye in boiling water; leaf surfaces (especially abaxial surface) ± evenly pubescent throughout; corolla orange, subfusiform in bud, 26–43 mm long, externally glabrous or sparsely pubescent near base of tube with inconspicuous glandular and eglandular trichomes to 0.1 mm long or pubescent throughout (or only on distal portion of lips) with eglandular (and sometimes glandular trichomes), lower lip usually recoiled. Native to Mexico. The species is very similar to, and is often confused with, *J. spicigera*.

Bexar Co.: *H. Parks s.n.* (GH). **Maverick Co.:** *M. Nee 25402* (F). **Nueces Co.:** *A. Traverse 1779* (BRIT). **San Patricio Co.:** *F. Jones 581* (SMU). **Webb Co.:** *L. Shinners 32366* (SMU).

6. **Justicia spicigera** Schltdl. (muicle, Mexican honneysuckle)
Shrubs to 1 m (or more) tall; stems and leaves yielding a bluish dye in boiling water; leaf surfaces glabrous or pubescent with trichomes mostly restricted to major veins; corolla orange, fusiform in bud, 30–55 mm long, externally sparsely and inconspicuously pubescent near base of tube with glandular trichomes to 0.1 mm long, otherwise glabrous, lower lip recoiled. Native to Mexico. Cultivated throughout Mexico for ornamental and medicinal purposes, and for use as a dye.

Cameron Co.: *R. Runyon 1065* (TEX). **Harris Co.:** *A. Traverse 1997* (BRIT). **Hidalgo Co.:** *R. Fleetwood 8005* (TEX).

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NOMENCLATURAL CHANGES FOR SOME TAXA IN THE OREGON FLORA

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ABSTRACT

Five nomenclatural changes are proposed at the species and subspecies level, based on taxonomic concepts adopted during the preparation of generic treatments for the Oregon Flora Project. The affected genera are *Crepis-Askellia* (Asteraceae), *Trillium* (Melanthiaceae), *Silene* (Caryophyllaceae), and *Limnanthes* (Limnanthaceae).

RESUMEN

Se proponen cinco cambios nomenclaturales a nivel de especie y de subspecie, basados en conceptos taxonómicos adoptados durante la preparación de los tratamientos genéricos para el Proyecto de Flora de Oregón. Los géneros afectados son *Crepis-Askellia* (Asteraceae), *Trillium* (Melanthiaceae), *Silene* (Caryophyllaceae), y *Limnanthes* (Limnanthaceae).

ASKELLIA VS. CREPIS

Askellia was assigned by Weber (1984) to the 8 species he recognized as comprising section *Ixeridopsis* Babc. of the large genus *Crepis* (Babcock 1947, p. 212). He noted, in particular, that the chromosome base number of this section, $x = 7$, was unique in *Crepis*. However, his proposed new genus is not used as a segregate of *Crepis* in recent North American floras (Welsh et al. 1987; Douglas et al. 1988; Bogler 2006). In deciding to recognize *Askellia* as a separate genus, we are following the recommendation of Enke and Gemeinholzer (2008), who performed a phylogenetic cladistic study of a large representative sample of *Crepis* taxa (77 species) with data from nrITS and *matK* sequences. Their results placed *C. nana* and *C. flexuosa*, from section *Ixeridopsis*, as a sister clade to the combined clades of (1) *Crepis* proper (monophyletic), (2) species assignable to the segregate genus *Lagoseris*, and (3) the genera *Rhagadiolus* and *Lapsana*. According to these authors (p. 761), "… following the molecular, karyological, and morphological evidence, it is necessary to reassign the seven species of *Crepis* sect. *Ixeridopsis* to *Askellia*, a genus which was defined by Weber (1984) based on the unique number of chromosomes." Their conclusions are supported by a more recent phylogenetic study of numerous Asian Lactuceae genera (Zhang et al. 2011), using DNA data from nrITS, plastid *trnL-F* and *psbA-trnH* loci.

The most widespread American species of section *Ixeridopsis* is *Crepis nana* Richardson, comprising ssp. *nana* and ssp. *ramosa* Babc. Weber assigned the name *Askellia nana* (Richardson) W. A. Weber to the species and made a new combination in it for ssp. *ramosa*. However, in the synonymy for *C. nana* given in Babcock's monograph (1947, p. 541), the first mentioned name is *Prenanthes pygmaea* Ledeb. (Ledebour 1815). Although the epithet "*pygmaea*" is not available in *Crepis*, due to the earlier *Crepis pygmaea* L., it has priority and should replace the epithet "*nana*," dated 1823. We therefore propose the following new combinations, for use by authors who wish to recognize *Askellia* as a separate genus.

Askellia pygmaea (Ledeb.) K.L. Chambers & S.C. Meyers, comb. nov. BASIONYM: *Prenanthes pygmaea* Ledeb., Mem. Acad. Imp. Sci. St. Petersbourg Hist. Acad. V, ser. 5:553. 1815. TYPE: 18. *Hieracium*, var. II, *foliis radicalibus ovatis, dentatis*, tab. 7, fig. 3 (Gmelin 1752, p. 20), LECTOTYPE by C.F. Ledebour (1846, p. 838, *sub Youngia pygmaea á. nana*, with the figure specified as the type–"certe quoad icon."). TYPE LOCALITY: SIBERIA: probably ca. 92° E. Lat., 55° N. Long. "ultra fluvium Janiseam," i.e. above the Yenisy River.

Askellia pygmaea (Ledeb.) K.L. Chambers & S.C. Meyers ssp. **ramosa** (Babc.) K.L. Chambers & S.C. Meyers, comb. nov. BASIONYM: *Crepis nana* Richardson ssp. *ramosa* Babc., Univ. Calif. Publ. Bot. 22:542–544. 1947. TYPE: U.S.A. WASHINGTON: Jefferson Co.: above Lake Constance, 11 Aug 1931, *J.W. Thompson 7943* (HOLOTYPE: UC 470750).

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It is safe to apply the epithet "*pygmaea*" to the taxon *Crepis nana* ssp. *nana*, since Ledebour described the plant with such phrases as "(T)ota plantam. … in formam hemisphaerii crescit. … Caulis brevissimus (sic!). … foliis numerosissimis." This description is borne out by the lectotype figure in Gmelin (1752). Babcock synonymized *Prenanthes pygmaea* with ssp. *nana* on the above cited page of his monograph. Ledebour (1846, p. 838) made the combination *Youngia pygmaea* (Ledeb.) Ledeb. ά. *nana* (Richardson) Ledeb., citing *Prenanthes pygmaea* Ledeb. as synonymous with this variety. In his 1815 description of *P. pygmaea*, Ledebour had made a syntype of 2 polynomial varieties of Gmelin's (1752) "18. *Hieracium*" species. Just 1 of these was given as the type (effectively a lectotype) in his 1846 publication. It was suggested by Babcock (1947, p. 544) that a second variety described by Ledebour (*op. cit.*), given as *Youngia pygmaea* β. *flaccida* (Ledeb.) Ledeb. and based on the other of Gmelin's 2 "18. *Hieracium*" varieties, might represent a minor variant of *C. nana* ssp. *ramosa*. Fortunately, such varietal epithets do not interfere with the priority of names at the subspecific level.

TRILLIUM

Trillium parviflorum Soukup (Soukup 1980) has attracted considerable attention from northwest American botanists interested in this genus. The name applies to the northern segment of *Trillium albidum* Freeman (Freeman 1975) found in southwestern Washington and the northern Willamette Valley, Oregon. It was maintained as a separate species by Case (2002). However, the results of a study by Bledsoe (1993) are best interpreted by making *T. parviflorum* a subspecies of *T. albidum*. A clinal relationship in morphology was shown to exist between the former entity (whose type locality is Ft. Lewis, Pierce County, Washington) and the latter (type locality near Selma, Josephine County, Oregon), with populations in the Willamette Valley, from Polk and Marion counties to at least as far south as Sutherlin, Douglas County, exhibiting a mixture of vegetative and floral traits of the 2 nominal extremes. This cline of variation in western Oregon was also described in detail by Dusek (1980), who informally proposed, but did not validly publish, a hybrid name for the intermediate plants.

It is appropriate to recognize this pattern of north-to-south intergradation between the 2 taxa with the following proposed new combination:

Trillium albidum Freeman ssp. **parviflorum** (Soukup) K.L. Chambers & S.C. Meyers, comb. nov. BASIONYM: *Trillium parviflorum* Soukup, Brittonia 32:330. 1980. TYPE: U.S.A. WASHINGTON. Pierce Co.: Ft. Lewis Military Reservation, 21 Mar 1979, *Soukup, Dusek & Graves s.n.* (HOLOTYPE: CINC).

SILENE

Silene serpentinicola T.W. Nelson & J.P. Nelson (2004) was described as a red-flowered taxon distinct from *S. californica* Durand (*S. laciniata* Cav. ssp. *californica* [Durand] J. K. Morton). It was said to be endemic to serpentines of the Smith River drainage in Del Norte County, California, and adjacent Oregon. By chance, this silene had been incorporated in the cytological and genetic researches of A. R. Kruckeberg (1960, 1961) through a collection he had made at Gasquet on the Smith River, under the name *S. californica*, and counted as hexaploid with $2n = 72$ (*Kruckeberg 3919*, WTU). Kruckeberg (1961) noted the similarity of these red-flowered plants to *S. hookeri* Nutt., whose flower color is described by Hitchcock and Maguire (1947, p. 44) as "white to pink, cerise, violet, or nearly purple." The chromosome number of *S. hookeri* is consistently hexaploid, $2n = 72$ (Kruckeberg 1960), unlike *S. californica*, in which the number $2n = 48$ (tetraploid) was counted in 5 accessions and $2n = 96$ (octoploid) in 1 accession (Kruckeberg 1954, 1960).

In an interspecific crossing program (Kruckeberg 1961), 2 hybrids were produced between hexaploid *S. hookeri* and the red-flowered Gasquet hexaploids. The first of these showed 80% stainable pollen and the second 65%. In the pollen tetrads he examined, the ratios of normal tetrads to those with micronuclei or microcytes were 142:9 and 98:9, respectively. In the meiotic cells studied, metaphase II and telophase II, the only stages seen, were consistently normal (Kruckeberg 1961, p. 324). These results are equivalent to, or better than, the numerous within-species homoploid crosses reported in table 4 of Kruckeberg's paper.

As treated in Flora of North America (Morton 2005, p. 206), *Silene serpentinicola* is differentiated from *S. hookeri* and *S. laciniata* ssp. *californica* by "its erect, more or less solitary flowering stems and large, clearly vis-

ible petaloid appendages in the flowers." In the year 2000, K.L. Chambers, in company with Henrietta Chambers, Susan Kephart, Veva Stansell, and Charlene Simpson, collected vouchers of *S. serpentinicola* at 5 sites in northwestern Del Norte County (see Appendix). These show the same deep-seated taproot and slender, spreading, often branched rhizomes (called "stem bases" by Hitchcock & Maguire 1947) as in *S. hookeri*, the erect, above-ground, mostly unbranched stems (varying from 7–24 cm in our samples) being well within the size range of *S. hookeri* (2–25 cm per Hitchcock & Maguire, *op. cit.*). The petal blade dissection is the same as described for *S. hookeri*, with 2 larger medial lobes and 2 smaller lateral ones, but sometimes with an extraneous, smaller petal inserted at the base of the blade where the usual corolla appendages are found. This is merely an occasional feature, not a regular one as implied by Morton, above. Nelson and Nelson (2004) confusingly described the petals as "more or less equally two-lobed, each lobe with a lateral tooth." The calyces and distal stems in our plants are densely glandular-pubescent, a characteristic also found in *S. hookeri* ssp. *pulverulenta* (M. Peck) C. L. Hitchc. & Maguire. From our study of morphological variation in the sampled populations, plus the cytological and crossing results of Kruckeberg (1960, 1961) we see no reason to keep *S. serpentinicola* as a species separate from *S. hookeri*, despite the supposed differences inferred by Nelson and Nelson (2004) in their initial description of the taxon.

A species of *Silene* with "deep scarlet" flowers, was reported from "the southwest corner of Oregon" by Howell (1897) under the name *S. californica*. His herbarium voucher (ORE 30680), representing *S. serpentinicola*, is labeled "OREGON. Coast Mountains, fortieth parallel. Thomas Howell. June 8th. 1884." This must be a typographical error for 42nd parallel, the southern boundary of the state. A likely locality would be on serpentines along the old stagecoach route to the southern Oregon gold fields, between Gasquet and present-day O'Brien, Josephine County. There are no reports of recent collections of the taxon in Oregon.

We propose that the evident cytological, genetic, and morphological similarities, other than corolla color, between *Silene serpentinicola* and *S. hookeri* are best expressed taxonomically at the subspecific level through the following new combination:

Silene hookeri Nutt. ex Torr. & A. Gray ssp. **serpentinicola** (T.W. Nelson & J.P. Nelson) K.L. Chambers & S.C. Meyers, comb. nov. BASIONYM: *Silene serpentinicola* T.W. Nelson & J.P. Nelson, Madrono 51:384. 2004. TYPE: U.S.A. CALIFORNIA. Del Norte Co.: T18N, R1E, Sec. 34, elev. 589 m, Low Divide road 8.85 mi N of junction with North Bank road, serpentine road cut, 20 Jun 2002, *T.W. Nelson & S. Carothers 9175* (HOLOTYPE: HSC).

LIMNANTHES

Limnanthes floccosa Howell (1897) is considered by taxonomists and authors of contemporary floras (Arroyo 1973; Ornduff 1993; Kozloff 2005; Morin 2010), to contain 5 subspecies: *L. f.* ssp. *bellingeriana* (M. Peck) C.T. Mason, *L. f.* ssp. *californica* Arroyo, *L. f.* ssp. *floccosa*, *L. f.* ssp. *grandiflora* Arroyo and *L. f.* ssp. *pumila* (Howell) Arroyo.

A recent study, using data obtained from microsatellite analyses, measured the amount of gene exchange occurring between selected sympatric populations (Meyers 2010). A total of 240 individuals, 120 of *L. f.* ssp. *floccosa* and 120 of *L. f.* ssp. *grandiflora*, were collected from 3 vernal pools (40 each pool) and surveyed. The results indicated that little or no gene exchange was occurring between wild populations of these subspecies. Additionally, 40 individuals of *L. f.* ssp. *floccosa* and 40 of *L. f.* ssp. *grandiflora* were crossed by hand, in both directions, in a greenhouse. Only 6% of the hybrid seeds obtained successfully germinated. Of the surviving germinants, most were depauperate in morphology and died within 1 to 3 weeks of emergence. The plants that reached maturity showed hybrid vigor but were sterile and produced no seeds.

Under the tenets of all biological species concepts, complete or nearly complete reproductive isolation must occur between two taxa in order that species status be conferred (Coyne & Orr 2004). The high levels of both pre- and post-zygotic reproductive isolation existing between *L. f.* ssp. *floccosa* and *L. f.* ssp. *grandiflora* meet this criterion. We therefore conclude that, according to this species concept, *L. floccosa* ssp. *floccosa* and *L. floccosa* ssp. *grandiflora* are parts of 2 distinct species.

The question of the placement of the remaining 3 subspecies of *L. floccosa* can also be addressed, based on

a molecular phylogenetic analysis included in the Meyers (2010) study. Using whole chloroplast genomes and partial mitochondrial and nuclear genomes, this analysis revealed that 2 distinct clades exist within *L. floccosa*. The first clade comprises the sister taxa *L. f.* ssp. *grandiflora* and *L. f.* ssp. *pumila*. The other contains the remaining *L. floccosa* subspecies *bellingeriana*, *californica* and *floccosa*.

Using commonly recognized phylogenetic species concepts (Baum & Donoghue 1995), the subspecies of the *L. floccosa* complex could be reclassified by a number of schemes. These range from elevating all subspecies to species status, to leaving all taxa at their current subspecific status within *L. floccosa*. However, given the results of the hybridization experiments and microsatellite study, in combination with the molecular phylogenetic analysis, we propose a conservative yet evolutionarily appropriate new arrangement of the *L. floccosa* subspecies. This involves the splitting of *L. floccosa* into 2 species: *L. pumila*, containing *L. p.* ssp. *pumila* and *L. p.* ssp. *grandiflora*, and *L. floccosa*, made up of *L. f.* ssp. *floccosa*, *L. f.* ssp. *bellingeriana* and *L. f.* ssp. *californica*. *Limnanthes pumila* was originally described as a distinct species (Howell 1897), hence only 1 new subspecific combination is required:

Limnanthes pumila Howell ssp. **grandiflora** (Arroyo) S.C. Meyers & K.L. Chambers, comb. nov. BASIONYM: *Limnanthes floccosa* ssp. *grandiflora* Arroyo, Brittonia 25:188. 1973. TYPE: U.S.A. OREGON. Jackson Co.: Modoc Road, 0.8 mi S of jct. with Hwy. 234, 23 Apr 1970, *M.T. Kalin 7030A* (HOLOTYPE: NY; ISOTYPE: UC).

APPENDIX

The following specimens of *Silene hookeri* ssp. *serpentinicola* referred to in the above discussion are deposited at OSC. All locations are on serpentine substrates in Del Norte County, California.

0.3 miles up Old Gasquet Toll Road from North Fork Road, Gasquet, by a trash disposal area, *K.L. Chambers 6124*, 15 Jun 1998; same location, *K.L. Chambers et al. 6218*, 12 Jun 2000, sheets 1 and 2 (packet of 13 petals dried separately); Humboldt Flat on French Hill Road south of Gasquet, 3.3 miles from junction with Hwy. 199, *K.L. Chambers et al. 6219*, 12 Jun 2000; 10-mile marker on Road 305 near Low Divide, T18N, R1E, Sect. 34/35, *K.L. Chambers et al. 6221*, 13 Jun 2000 (near type locality); Low Divide, Road 308, T18N, R1E, Sect. 35, at Alteville Historical Site, *K.L. Chambers et al. 6222*, 13 Jun 2000; Wimer Springs, T18N, R1E, Sect. 14, *K.L. Chambers et al. 6224*, 13 Jun 2000.

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BOOK REVIEW

BRUCE A. SORRIE. 2011. **A Field Guide to Wildflowers of the Sandhills Region: North Carolina, South Carolina, and Georgia.** 2011 (ISBN 978-0-8078-7186-7, pbk.). A Southern Gateways Guide. The University of North Carolina Press, 116 South Boundary Street, Chapel Hill, North Carolina 27514-3808, U.S.A. (**Orders:** 800-848-6224, www.uncpress.unc.edu). $25.00, 378 pp., color figures throughout (540+), 5½" × 8½".

A Field Guide to Wildflowers of the Sandhills Region: North Carolina, South Carolina, and Georgia is an exceptional and unique wildflower guide to a fascinating and biodiverse area in the southeastern United States. There's standard introductory material, e.g., description of the Sandhills Region, format and style, flowers and leaves (illustrated), glossary, but the meat of this book lies in the beautiful wildflowers that have been photographed and described from the nine distinct natural communities or habitats in the covered region. The natural areas are arranged by habitat, with color tabs for ease of browsing.

The author concludes with a list of suggested sites in the Sandhills Region to visit and enjoy some of the beauty found there and revealed in this book. The author's love for wildflowers and natural communities comes through on every page. Every wildflower enthusiast and botanist would enjoy this wildflower treasury. With a purchase price of only $25.00, you will definitely get your money's worth. Enjoy!—*Barney Lipscomb, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

IDENTITY OF *CATALPA TIBETICA* (BIGNONIACEAE)

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ABSTRACT

Catalpa tibetica (Bignoniaceae) is included within the circumscription of *C. bignonioides*, a North American species. The genus *Catalpa* is thereby reduced from 10 species to nine, and the number of native Chinese species from four to three. A preliminary synonymy for *C. bignonioides* is presented, including *C. tibetica*. The correct neotype and epitype for *C. bignonioides* are indicated.

RESUMEN

Catalpa tibetica (Bignoniaceae) se incluye dentro de los límites de *C. bignonioides*, una especie de Norte América. El número de especies del género *Catalpa* se reduce de 10 a nueve especies, y las especies nativas de China pasan de cuatro a tres. Se presenta una sinonimia preliminar para *C. bignonioides*, incluyendo *C. tibetica*. Se indican el neotipo y epitipo correctos para *C. bignonioides*.

INTRODUCTION

The genus *Catalpa* Scop. (Bignoniaceae Juss.) has been treated as composed of 10 species in two well-defined sections, *Catalpa* and *Macrocatalpa* Griseb. (Paclt 1952; Gentry 1992). *Catalpa* section *Catalpa* contained six species of deciduous trees with a disjunct distribution between temperate East Asia (four species) and eastern North America (two species). The two North American species, *C. bignonioides* Walter (common catalpa or Indian bean) and *C. speciosa* E.Y. Teas (hardy catalpa), are frequently cultivated and widely naturalized in urban areas of the eastern United States (Rehder 1940). *Catalpa* section *Macrocatalpa* was composed of four species of evergreen or semi-evergreen trees restricted to the Antilles, and with the exception of *C. longissima* (Jacq.) Dum. Cours., are not in cultivation (Gentry 1992). While the North American species are well known, the Asian and Antillean species are not. Of the four species of Asian *Catalpa* currently recognized (*C. bungei* C.A. Mey., *C. fargesii* Bureau, *C. ovata* G. Don, and *C. tibetica* Forrest) (Zhang & Santisuk 1998), all but *C. tibetica* exist in cultivation.

The temperate catalpas are often described as some of the most beautiful of hardy flowering trees, with showy panicles of white, yellow, or pink flowers, depending on the species (Clarke & Taylor 1980; Dirr 1998). Furthermore, their broad adaptability, both in hardiness and abiotic stress tolerances, provides ample opportunity through systematic breeding to develop novel cultivars for the urban landscape (Olsen et al. 2006a, b). Olsen et al. (2006a) amassed a collection of catalpa and catalpa-relatives that was transferred to the U.S. National Arboretum and forms the foundation for our catalpa research and breeding program. The collection has been expanded, and now contains over 40 accessions representing both wild material and cultivated varieties. Trueness-to-type was questioned by Olsen et al. (2006a) for several accessions of *Catalpa bungei* and *C. fargesii* in the collection, and only a handful of correctly identified accessions have been located in the U.S. and Europe. During the search for cultivated species of *Catalpa* for inclusion in our breeding work, we were unable to locate living plants of *C. tibetica*, a species collected and described by George Forrest from southeastern Tibet, and known only from the type specimens. The locality data provided by Forrest suggested that *C. tibetica* might represent a significantly improved source of cold-hardiness for catalpa breeding.

GEORGE FORREST

George Forrest was one of the most productive explorers and collectors in western Yunnan, China, and the southeastern corner of Tibet in the early 20th Century (Cooper et al. 1935; Cox 1945; Cowan 1952; McLean

2004). Over more than 25 years, from 1906 to 1931, Forrest carried out seven expeditions to China. His collecting efforts ranged from seven months to two years and 10 months in duration. He made more than 24,155 plant collections, and died in China near Tengyueh, present day Tengchong, on the 5th of January, 1932 near the end of what was supposed to be his last expedition.

During his first expedition to Yunnan from 1904 to 1906, Forrest learned the local languages and dialects and developed an organization for efficient, highly productive collecting in Yunnan and Tibet (Cox 1945; McLean 2004). He trained a cadre of men, mostly of the Nakhi (Naxi) people from U-lu-kay (Snow Mountain Village) about 15 miles (24 km) north of Lichiang (Lijiang), as collectors, until he had more than 20 trained men in whom he had full confidence that they could work without his immediate supervision (Cox 1945; McLean 2004). For a collecting season, he would establish his headquarters in a suitable village or town. Forrest would collect in the region around his headquarters, and send teams of men to collect in various locations outside of the headquarters' region. Sometimes teams would be gone two to three months at a time, traveling long distances and collecting in difficult terrain. This system of collecting was very productive because of the extensive, widely separated areas that would be worked during a single collecting season. In addition most, if not all, areas of interest were visited at least two or more times during the flowering and fruiting seasons to insure that plants of horticultural interest were collected in both flowering and fruiting states, facilitating their study, identification, and seed collection for propagation. There are several drawbacks to this system, which we have experienced in our own and colleagues' collecting expeditions. When large volumes of material are collected and processed, specimens of different species can be accidently mixed or switched. Collection data, including collection numbers, descriptive information, or locality data, can be assigned to the wrong materials. Attempting to gather materials from the complete life-cycle of a species can lead to the association of materials of different species that are very similar. Cox (1945) reported that "on several occasions mistakes were made and [Forrest's] seed did not correspond with the name."

Forrest was seriously ill during most of 1919 (McLean 2004: 147). His doctor advised him to remain in Tengyueh (Tengchong), so he established his headquarters there and remained there for the entire year (McLean 2004: 147). He still managed to send collecting teams to at least six different mountain ranges during the year covering 25–29° N latitude and reaching as far as 250 miles (400 km) away in Tibet (McLean 2004: 147). In May, he dispatched three collectors with two mules to work in Tsarong, Tibet under the supervision of Père Valentin at the Roman Catholic Mission in Tsedjrong just north of Tsekou (Chigu) (McLean 2004: 142, 144). The three collectors were told that they would be paid "a small reward for each new species found" (McLean 2004: 144). This team was probably the one that worked furthest from Tengyueh (Tengchong) during 1919.

In 1919 this three-man collecting team made two collections of *Catalpa* to which Forrest assigned his nos. *18926* collected in August and *18950* in June and described as *Catalpa tibetica* citing his collections *18926* and *18950* without indicating either to be the type (Forrest 1921). According to data on the labels, they were both collected in Tsarong on the Salween-Kiu-chiang divide at latitude 28° 40' N and longitude 98° 15' E. In Google Earth (release 5.0), this latitude and longitude indicates a place over 4,300 m above sea level. *Forrest 18926* consists of fruiting specimens with mature seeds; *Forrest 18950* comprises flowering specimens. The herbarium label of *Forrest 18950* describes the flowers as "creamy-yellow, flushed and marked pale purple and yellow". Forrest's hand-written field book, volume IV, F12345 (Forrest 1929) describes the flowers as "creamy white, flushed and marked pale purple and yellow". Forrest compared his new species to *C. ovata*, and concluded that his species "does not agree in size of flower, in size and shape of fruit, nor in the seeds with numerous specimens of the well known *C. ovata* G. Don."

The Royal Botanic Garden, Edinburgh holds in their archives George Forrest's field books and his correspondence with their staff. Volume IV, F12345, of his field books covers the collection numbers 17906–19054 from April to November of 1919. The page and collection numbers are stamped in blue ink, and the remainder was hand written also in blue ink. Entry number 18926 is on page 188, and number 18950 is on page 193. The collection data exactly matches that published by Forrest (1929) in his field notes of 1917–19 for non-rhodo-

dendrons, but differs in the description of the corolla color, "cream-white" in the field book and "creamy-yellow" on the herbarium labels and in the protologue of *C. tibetica* (Forrest 1921). Forrest wrote "*Catalpa ? tibetica* Forr." as the determination for *Forrest 18926* and "*C. tibetica* G. Forr." as the determination for *Forrest 18950*.

We examined Forrest's correspondence with the Royal Botanic Garden staff for 1919 through August 1922, including letters from him and copies of letters sent to him, mainly to and from Sir Isaac Bayley Balfour, Regius Keeper during that period. The principal topics of the letters were Forrest's collecting and the genera *Rhododendron* L. and *Primula* L., both of special interest to Sir Isaac. There was no mention of *Catalpa* or collection numbers *18926* and *18950*, and no reference to Forrest's publication of *Catalpa tibetica* (Forrest 1921).

Catalpa tibetica has been accepted in the principal Chinese floras (Kunming Institute of Botany 1979; Wang et al. 1990; Zhang & Santisuk 1998), where the corolla was described as yellowish white and the fruit as approximately 1 cm in diameter. Yao and Huang (1980) presented a synopsis of all taxa of *Catalpa* without keys or descriptions. They did not examine the syntypes of *C. tibetica*, but examined a specimen purported to be *C. tibetica* (China, Yunnan Province, at bank of a creek near the front gate of the Construction Bureau of Lijiang, 4 Sep 1948, *Qin Ren Chang 31019*). They concluded that the specimen was of *C. bignonioides*, a species not native to China. They never saw an authentic specimen of *C. tibetica*.

In July of 2009 we examined the specimens of *Forrest 18926* and *18950* in the herbaria of the Royal Botanic Garden, Edinburgh (E), Royal Botanic Gardens, Kew (K), and Muséum National d'Histoire Naturelle, Paris (P). Images of those collections are available for viewing on the Internet sites of those institutions. We were immediately struck by the similarity of the syntypes of *C. tibetica* and the North American *C. bignonioides* and *C. speciosa*. Comparison of the Forrest collections to wild and cultivated specimens of the North American species convinced us that the syntypes of *C. tibetica* fall within the circumscription of *C. bignonioides*. The large white corollas and the large fruits and seeds are exactly like those of *C. bignonioides* and unlike those of the Chinese *C. bungei*, *C. fargesii*, and *C. ovata*. Therefore we here lectotypify *C. tibetica*, and place it in synonymy under *C. bignonioides*.

Forrest 18926 and *18950* were not collected in Tsarong, Tibet. Because Forrest had sent the three-man collection team to Tsarong, he erroneously labeled the two collections as having been made there. In 1904 Forrest traveled from Tengyueh (Tengchong) to Tseku (Chigu) by way of Tali (Dali), Lichiang (Lijiang), Chung-tien (Zhongdian) and then crossed the Yangtze (Jinsha Jiang) River, Beima Shan mountains, and finally the Salween (Nu Jiang) River (Davies 1909; McLean 2004). In 1919 Forrest's three-man collecting team possibly traveled via Tali (Dali) and Lichiang (Lijiang) and then up the Yangtze (Jinhsa Jiang) River valley to reach Tsarong. Spurred on by the promise of a monetary reward for each new species, the three-man collection team encountered a mature tree of *C. bignonioides*, either cultivated or adventive, somewhere along their route in Yunnan, China and collected it. Forrest correctly recorded its flower color as creamy-white in his field book, but when preparing the herbarium labels for *Forrest 18950* and publishing *C. tibetica*, changed the flower color to creamy-yellow, which was wrong. In his field book Forrest recorded the habit of *18926* as "Tree of ______ ?" and of *18950* as "Shrub or tree of ______?," a further indication of his personal lack of knowledge concerning these two collections. This uncertain habit data was placed on the herbarium labels of *Forrest 18926* and *18950*, but not included in the publication of *C. tibetica* (Forrest 1921).

CATALPA BIGNONIOIDES AND SELECTED SYNONYMS

Catalpa bignonioides Walter, Fl. carol. 64. 1788. TYPE: UNITED STATES. SOUTH CAROLINA: *Fraser 28-D* (NEOTYPE (Reveal et al. 1990, as "holotype"): BM-SL, f. 28!, Rembert 1980: Fig. 7); Lexington Co.: just behind (N of) truck stop and "44 Restaurant," on E side of SC Hwy 34 at I-20, about 9 mi SE of Leesville, 20 May 1997, *John B. Nelson 18315* (EPITYPE (Ward 2007d, as "neotype"): GH!; ISOEPITYPE: USCH).

Bignonia catalpa L., Sp. pl. 622. 1753; *Catalpa cordifolia* Moench, Methodus 464. 1794, nom. superfl.; *Catalpa ternifolia* Cav., Descr. pl. 26. 1801, nom. superfl.; *Catalpa communis* Dum. Cours., Bot. cult. 2:189. 1802, nom. superfl.; *Catalpa syringifolia* Sims, Bot. Mag. 27: t. 1094. 1806, nom. superfl.; *Catalpium amena* Raf., Fl. ludov. 139. 1817, nom. superfl.; *Catalpa catalpa* (Linnaeus) H. Karsten, Deut. Fl. 927. 1882, nom. inval. TYPE: *Bignonia urucu foliis, flore cordide albo*, Catesby, Nat. hist. Carolina 1: t. 49. 1730 (LECTOTYPE (Reveal et al. 1990)).

Catalpa syringifolia Sims var. *nana* Ed. Otto & A. Dietr., Allg. Gartenzeitung 19(14):112. 1851. TYPE: not designated.

Catalpa syringifolia var. *aurea* anon., Gard. Chron. 41:1322. 1871. TYPE: not designated.

Catalpa arborea Baill. in Payer & Baillon, Leçons fam. nat. 214. 1872. TYPE: not designated (not found in P-Baillon, 2009).

Catalpa umbraculifera G. Ugolini, Bull. Reale Soc. Tosc. Ortic. 13:330. 1888. TYPE: not designated.

Catalpa bignonioides Walter var. *aurea* Lavallée ex Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *aurea* (Bureau) Paclt, Candollea 13:263. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *nana* Bureau, Nouv. Arch. Mus. Hist. Nat., ser. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *nana* (Bureau) Paclt, Candollea 13:261. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *variegata* Bureau, Nouv. Arch. Mus. Hist. Nat., sér. 3, 6:183. 1894; *Catalpa bignonioides* Walter f. *variegata* (Bureau) Paclt, Candollea 13:261. 1952. TYPE: not designated.

Catalpa bignonioides Walter var. *koehnei* Dode, Bull. Soc. Dendrol. France 1907(6): 206. 1907; *Catalpa bignonioides* Walter f. *koehnei* (Dode) Paclt, Candollea 13:262. 1952. TYPE: not designated.

Catalpa syringifolia Sims var. *pulverulenta* W. Paul & G. Paul in Anonymous, Gard. Ill. 30:289. 1908; *Catalpa bignonioides* Walter var. *pulverulenta* (W. Paul & G. Paul) Bean, Trees and Shrubs Hardy in the British Isles 1:312. 1914; *Catalpa bignonioides* Walter f. *pulverulenta* (W. Paul & G. Paul) Paclt, Candollea 13:263. 1952. TYPE: not designated.

Catalpa speciosa E.Y. Teas var. *albo-variegata* F. G. Schwer., Mitt. Deutsch. Dendrol. Ges., ed. 2, 2:289. 1910; *Catalpa speciosa* E.Y. Teas f. *albo-variegata* (F. G. Schwer.) Rehder, Bibl. cult. trees 659. 1949. TYPE: not designated.

Catalpa speciosa E.Y. Teas var. *pulverulenta* W. Paul & G. Paul in W.T., Gard. Mag. (London) 53:30. 1910; *Catalpa speciosa* E.Y. Teas f. *pulverulenta* (W. Paul & G. Paul) Rehder, Bibl. cult. trees 659. 1949. TYPE: not designated.

Catalpa tibetica Forrest, Notes Roy. Bot. Gard. Edinburgh 13:155. 1921, syn. nov. TYPES: CHINA. YUNNAN: Jun 1919, *Forrest 18950* (LECTOTYPE, here designated: E No. 00287957!; ISOLECTOTYPES: E No. 00287958!, K!, P!); same locality, Aug 1919, *Forrest 18926* (SYNTYPES: E No. 00287955!, E No. 00287956!).

Catalpa bignonioides Walter f. *rehderi* Paclt, Candollea 13: 259. 1952. TYPE: CZECH REPUBLIC. Central Bohemia, Prague, ca. 290 m elev, *Paclt 3* (HOLOTYPE: PR).

This large list of synonyms is preliminary. Numerous minor variants of *C. bignonioides* have been discovered in cultivation during the last two and a half centuries, and many of them have been given scientific names. In our opinion, they should be treated as cultivars under the *International Code of Nomenclature for Cultivated Plants* (Brickell et al. 2004), and not given formal scientific recognition.

EARLY EUROPEAN INTRODUCTIONS OF *CATALPA BIGNONIOIDES*

Mark Catesby (1730) discovered *Catalpa bignonioides* in the western Carolinas, and introduced it into cultivation in eastern South Carolina. He also introduced it into England in 1726 (Aiton 1789; Saint-Hilaire 1804; Sweet 1826; Loudon 1838; Beck von Mannagetta & Abel 1890; Sargent 1894; Boulger 1904; Elwes & Henry 1912; Bean 1914), and by 1754 (Duhamel du Monceau 1755) it was being successfully cultivated in France. By 1812 (Loudon 1838) it was widely cultivated all over Europe, including Austria, France, Germany, Ireland, and Italy. Because of its abundant, beautiful spring flowering, it was rapidly and widely distributed to various temperate countries. By the early 18th Century, French Jesuits were resident in China (Lécrivain 2004; Thevenet 2004). Some of the Jesuit fathers, such as Armand David, Pierre-Nicolas Le Chéron d'Incarville, and Jean-André Soulié, were enthusiastic botanists and collectors. They made extensive collections of Chinese flora, both propagules and herbarium specimens, which they sent to Paris, and requested and received propagules of various plants from Paris. Perhaps *C. bignonioides* was one of the species that the French Jesuits introduced into China in the 18th or 19th Century.

The native distribution of *Catalpa bignonioides* has long been recognized as southwestern Georgia, western Florida, southern and central Alabama, Mississippi, and Louisiana, and perhaps the southeastern edge of Texas (Sargent 1894; Bureau 1894; Elwes & Henry 1912; Paclt 1952; Weniger 1996; Manning 2000), and modern treatments of all species of Chinese *Catalpa* (Kunming Institute of Botany 1979; Yao & Huang 1980; Wang et al. 1990; Zhang & Santisuk 1998; Fang et al. 2009) have not included *C. bignonioides* as a native Chinese species. In our opinion *C. bignonioides* is endemic to the southeastern United States, and was introduced into China as a horticultural plant because of its great beauty in the spring when flowering.

TYPIFICATION OF *CATALPA BIGNONIOIDES*

Traditionally, *Catalpa bignonioides* Walter has been treated as a replacement name for the earlier *Bignonia catalpa* L. or as a new species (Paclt 1952; Reveal et al. 1990; Ward 2006, 2007a). The alternative treatments have

resulted from varying interpretations of Walter's (1788:64) *C. bignonioides*. His treatment of the genus and species in *Flora Caroliniana* is brief:

12. *CATALPA*. *Cor.* monopetala, campanulata.
Cal 5-phyllus. *Rudimenta* tria staminum.
bignonioides 1. arbor. fol. cordatis.

Throughout the work, Walter gave neither authorities nor references for the names of the taxa nor did he cite specimens. In the preface, Walter stated that he had only Linnaeus' *Systema naturae* (1735), *Genera plantarum* (1737), and *Species plantarum* (1753) to work from (Walter 1788; Rembert 1980). When he followed Linnaeus the text was generally placed in Roman type, and when his treatment differed from Linnaeus, those differences were usually placed in italics (Reveal & Jarvis 2009).

Paclt (1952) was the first to inadvertently typify *C. bignonioides* in his synopsis of the genus. He gave the type of *C. bignonioides* as, "*Linnaeus* [?] in hb. BM. (Herb. Hort. Cliffort.), actually missing". Apparently Paclt assumed that *C. bignonioides* was a replacement for Linnaeus' *B. catalpa*, and so cited a specimen in the Clifford Herbarium, which was supposedly the basis for the first synonym cited by Linnaeus (1738, 1753) under *B. catalpa*, the polynomial in the *Hortus cliffortianus* (Linnaeus 1737:317). No specimen of *Catalpa* was found in an online search of the George Clifford Herbarium at the Natural History Museum, London, nor by Reveal et al. (1990).

Reveal et al. (1990), concluding that *C. bignonioides* was being described as new by Walter, cited the specimen of *C. bignonioides* in the Walter Herbarium at the Natural History Museum, London (BM-SL 28-D; Rembert 1980:Fig. 7) as the holotype. They assumed that Walter had used the one specimen in his herbarium.

Ward (2006, 2007a, b, c, d, 2008a, b) demonstrated that the Walter Herbarium actually is composed of John Fraser's collections. Of the identified specimens in the Walter Herbarium, 50% of the identifications are in the handwriting of Walter, and 33% in the handwriting of Fraser (Ward 2007a). The specimen of *C. bignonioides* in the Walter Herbarium bears the identification "*Catalpa bignonioides*" in Fraser's hand (Ward 2007d). Ward (2007d), after rejecting Fraser's specimen as a type because it is "a single broken leaf" and because it lacks linkage to Walter, effectively selected *John B. Nelson 18315* (GH) as the neotype for *C. bignonioides*, meeting all the requirements of Art. 7.11 of the ICBN (McNeill et al. 2006). Ward (2007d) did not cite nor mention the designation of a type for *C. bignonioides* by Reveal et al. (1990).

Catalpa bignonioides is in italics in Walter's (1788:64) *Flora Carolina*, signifying that it is different from Linnaeus' (1735, 1737, 1753) species. Walter placed *Catalpa bignonioides* in *Diandria, Monogynia*, probably a significant factor in his recognition of it as a new genus; Linnaeus (1737, 1753) placed *Bignonia catalpa* in *Didynamia, Angiospermia*. Finally, Walter used the specific epithet *bignonioides* rather than transforming Linnaeus' generic epithet *Bignonia* into a specific epithet for his species. We conclude that there is no homotypic linkage between Linnaeus' *B. catalpa* and Walter's *C. bignonioides*.

Since the specimen of *C. bignonioides* in the Walter Herbarium cannot be considered part of Walter's original material and there is no other original material that can be associated with the name (Ward 2007d), selection of a neotype is required. Article 9.8 of the *International Code of Botanical Nomenclature* (ICBN; McNeill et al. 2006) states, "the use of a term defined in the *Code* (Art. 9.1–9.7) as denoting a type, in a sense other than that in which it is so defined, is treated as an error to be corrected…" Reveal et al. (1990) identified the specimen of *C. bignonioides* in the Walter Herbarium (BM-SL 48-D) as a "holotype," which according to Art. 9.8 is a correctable error, and can be taken as a neotypification of *C. bignonioides* on *Fraser* (BM-SL 48-D).

Ward's (2007d) designation of *John B. Nelson 18315* (GH) as neotype of *C. bignonioides* could be considered an attempt to supersede the neotype of Reveal et al. (1990) under Art. 9.17, but there are no justifiable grounds for this, so the neotype of Reveal et al. (1990) cannot be superseded. The reason Ward gave for not choosing Fraser (BM-SL 48-D) as neotype was that it consists of a single, partial, broken leaf, an inadequate specimen for a neotype. Article 9.7 of the ICBN (McNeill et al. 2006) states, "an epitype is a specimen or illustration selected to serve as an interpretative type when the … previously designated neotype … is demonstrably ambiguous and cannot be critically identified for purposes of the precise application of the name…" Because of the very poor condition of *Fraser* (BM-SL 48-D), Ward (2007d) chose *Nelson 18315* (GH) as the neotype of *C. bignonioi-*

des. Ward's reasons for selecting *Nelson 18315* (GH) over *Fraser* (BM-SL 48-D) are also the reasons for selecting an epitype, so Art. 9.8 (McNeill et al. 2006) applies to Ward's type selection, which is actually an epitype.

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BOOK REVIEW

James W. Hinds and Patricia L. Hinds. 2007. **The Macrolichens of New England.** (ISSN 0077-8931, ISBN 13: 978-0-89327-477-1, ISBN 10: 0-89327-477-1, hbk., printed on FSC certified 86 lb. gsm glossy). Memoirs of The New York Botanical Garden, Volume 96:1–608. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** 718-817-8721, 718-817-8842 fax, http://www.nybgshop.org/NYBG-Press-p-1-c-333.html). $65.00, 584 pp., 10 tables, 14 line drawings, more than 400 color illustrations, glossary, index, 7¼" × 10¼".

The authors hope this book will serve as a true field guide but the larger size format, heavy weight, and thick, nonflexible hardback cover would preclude hand carrying or hiking with a book bag over long distances. More value would be realized as a reference book or identification manual at home or in the laboratory using the dichotomous keys and photographic images depicted at magnifications that make picture identification possible.

Macrolichens include species considered foliose and fruticose growth forms that are often larger, showy, and more conspicuous to the eye as the name macro implies and excludes microlichens that include mostly the smaller, less conspicuous crustose growth forms. This will make the keys and book more user friendly since a compound microscope is not required for identifications. Nevertheless, the lichens are a difficult group to identify because of the reliance on chemical characters that require different chemical reagents not readily available and mastery of an extensive vocabulary of terminology applied to the more than 25,000 species currently recognized.

The effective use of publication sidebars in the early topical sections, for example, "A classic study of sexual reproduction in lichens," "Colonization of land by lichens in the Precambrian Period?," Lichen biomonitoring used to discover areas with increased risks of lung cancer" among others, enlivens the narrative and introduces additional information that engages the reader's interest about lichens. Introductory sections will help the beginner grasp the biology, terminology, and economic importance of lichenology through the discussion of "What is a lichen?," "Ecological role of New England lichens," and "Human uses of New England lichens."

The biophysical region of New England covered in this book includes the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. A topical section that deserves special mention, for example, "Biophysical regions of New England and their macrolichen floras" gives helpful information that includes a map of the counties, geography, geology, climate, natural forest vegetation zones, major biographical zones, and specialized lichen habitats in New England, especially the saxicolous lichens on tombstones in cemeteries. Another section highlights "Changes in abundance and distribution of New England macrolichens during the last 100 years" based on an interesting Table 5 that lists the records of "Macrolichen species once found in 3 or more New England states but now in none," Table 6, "Macrolichen species with decreases of 3 or more New England states," and Table 7, "Macrolichen species with increases of 3 or more New England states" based on data gleaned from herbarium and field collections made over a long period of time. Some of these data are highlighted in the next topical section entitled "Rare or declining macrolichens of New England" and Table 9 lists the "New England Macrolichens that are regionally rare or declining" that includes a comments column with the number of sites, general location, state, and time period. These data increase the value of this regional publication.

A section on "How to collect and identify macrolichens" draws on the 35 years of field experience of the authors and should be required reading for any novice considering collecting lichens. I found Table 10, "Color reactions of selected lichen substances to spot test or ultraviolet fluorescence" especially helpful in getting this information at a quick glance.

Review continued on page 634

A NOMENCLATURAL CHANGE IN *VIOLA* (VIOLACEAE)

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ABSTRACT

In keeping with the use of varieties for infraspecific taxa in the treatment of *Viola* for the *Flora of North America* (Little & McKinney, in prep.), a nomenclatural change is proposed here to achieve consistency.

RESUMEN

De acuerdo con el uso de variedades para los taxa infraspecificos en el tratamiento de *Viola* para la *Flora de Norteamerica*, se propone aquí un cambio nomenclatural para conseguir coherencia.

Viola pinetorum Greene var. **grisea** (Jepson) R.J. Little, comb. nov. Basionym: *Viola purpurea* Kellogg var. *grisea* Jepson, Fl. Calif. 2:521. 1936. *Viola pinetorum* Greene subsp. *grisea* (Jepson) R.J. Little, Phytologia. 72:77–78. 1992.

Viola purpurea Kellogg, Proc. Calif. Acad. Sci. 1:55. 1855.

Viola pinetorum Greene, Pittonia 2:14. 1889. *Viola purpurea* Kellogg var. *pinetorum* Greene, Fl. Francisc. 243. 1891.

Edward L. Greene described *Viola pinetorum* in 1889 and reduced it without comment to a variety of *Viola purpurea* in 1891. Willis L. Jepson collected "dwarf," caespitose forms of this taxon from mountain ranges in southern California, which he described in 1936 as *Viola purpurea* var. *grisea*. The leaf blades of *Viola pinetorum* are typically much longer than wide, linear to narrowly lanceolate, oblanceolate, or obovate. The author believes *Viola pinetorum* is distinct from *Viola purpurea* and that var. *grisea* is distinct from var. *pinetorum*.

Variety *pinetorum* and the diminutive var. *grisea* have similar leaf shapes with margins irregularly lacerate, dentate, serrate, and sometimes more or less entire. The leaf margins of these taxa are usually strongly and markedly sinuate and undulate. However, evidence that leaves are undulate is obliterated when the leaves are pressed. The leaves of var. *grisea* appear distinctly gray in the field and are usually canescent to gray-tomentose. The leaves of var. *pinetorum* appear greenish in the field and are usually puberulent on both surfaces and purple-tinted abaxially. In June 2011, the author collected var. *grisea* from 3 locations in southern California, at elevations 2225–2500 m: Mt. Pinos and San Gabriel Mountains in the Transverse Ranges, and north of Bald Mountain (Tulare Co.) in the southern Sierra Nevada.

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BOOK REVIEW (CONTINUED)

James W. Hinds and Patricia L. Hinds. 2007. **The Macrolichens of New England.** (ISSN 0077-8931, ISBN 13: 978-0-89327-477-1, ISBN 10: 0-89327-477-1, hbk., printed on FSC certified 86 lb. gsm glossy). Memoirs of The New York Botanical Garden, Volume 96:1–608. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** 718-817-8721, 718-817-8842 fax, http://www.nybgshop.org/NYBG-Press-p-1-c-333.html). $65.00, 584 pp., 10 tables, 14 line drawings, more than 400 color illustrations, glossary, index, 7¼" × 10¼".

(*Review continued from page 632*)

The exceptional high quality printing of 400 color images at magnifications that enhance the recognition of key characters is a feature that facilitates identification and use of the keys using a hand lens or dissecting microscope. Unfortunately the high glossy surface of the paper at times reflects light and is a minor annoyance when reading text.

The heart of the book is the "General keys to New England macrolichens" that includes descriptions of 98 genera, 461 New England species, and 41 additional species known from adjacent states. A Quick Key Index on trees, on rocks, and on soil quickly locates the page numbers using the foliose growth form. Some foliose lichen keys use colors, lobe morphology and size and this also applies to the fruticose growth forms. The section "Genus and species descriptions of the macrolichens of New England" has the species descriptions as well as species keys based on morphology and not chemical characters. Included with the generic descriptions are comments, distribution, etymology, and common names and with the species descriptions are synonyms, illustrations, range/habitat, notes, and in some cases chemistry.

The Literature Cited section includes 19 pages that number approximately 469 references, the majority from 1950 to 2005 time period. There is a 9-page glossary of terminology used in the text of the book. There is an Index of Latin and English names.

This is a lot of book for a best bargain basement price of $65. There is much here that will appeal to users such as outdoor professionals in the forest and park service, visitor centers at state and national parks, summer visitors to the New England states, nature enthusiasts, the nature conservancy organizations, libraries, botanical museums and herbaria, botanists, ecologists, and of course in the hands of every lichenologist. If this book were rated based on 1 star (lowest) to 5 stars (highest) it would receive a 5 star must buy rank that far exceeds the scope of a regional publication.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

A PALYNOLOGICAL INVESTIGATION OF *DAPHNE PAPYRACEA* AND *DAPHNE BHOLUA* (THYMELAEACEAE) IN INDIA

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ABSTRACT

The pollen grains of three putative relatives (*Daphne bholua* var. *bholua*, *D. bholua* var. *glacialis*, *D. papyracea*) were studied to explore micromorphological variation aimed at identifying novel taxonomically helpful characters. Based on an examination of specimens collected from India the study taxa differed in several key palynological features, most notably in characters related to the ectoexine. The exine of *D. bholua* var. *glacialis* showed that the baculoidate, dome-shaped structure of the supratectal projections (STP) and the arrangement of the supratectal subunits (4 and free, or 5–6 and fused) were intermediate between *D. bholua* and *D. papyracea*. In addition, the mean grain diameter (29 µm), STP-pattern (semi-crotonoid), and exposed muri of the basal reticulum suggested that the pollen of *D. bholua* var. *glacialis* was more similar to the pollen of *D. papyracea* than to the typical variety of *D. bholua*. Preliminary palynological evidence indicates that the taxonomic status of *D. bholua* var. *glacialis* should be reevaluated with additional palynological and macromorphological data. The first valid publication date and correct authorship of *D. papyracea* is also clarified.

RESUMEN

Se estudió el polen de tres taxones putativamente relacionados (*Daphne bholua* var. *bholua*, *D. bholua* var. *glacialis*, *D. papyracea*) para explorar su variación micromorfológica con el objetivo de identificar nuevos caracteres de utilidad taxonómica. En base al examen de especímenes colectados en India encontramos que el polen de los taxones estudiados difiere en varios caracteres palinológicos, y más notablemente con aquellos relacionados con la ectexina. La exina de *D. bholua* var. *glacialis* presenta proyecciones supratectales (STP) baculoides con estructuras en forma de domo, y subunidades supratectales (4 y libres, o 5–6 y fusionadas) organizadas de un modo intermedio al de *D. bholua* y *D. papyracea*. Adicionalmente, el promedio del diámetro de los granos (29 µm), patrón de STP (semi-crotonoide), y los muros expuestos del retículo basal sugieren que el polen de *D. bholua* var. *glacialis* es más similar al de *D. papyracea* que al de *D. bholua*. Nuestros estudios preliminares indican que la posición taxonómica de *D. bholua* var. *glacialis* debe ser reevaluada con datos palinológicos complementarios y estudios macromorfológicos adicionales. La fecha válida de publicación y autoridades de *D. papyracea* también son clarificadas.

INTRODUCTION

Daphne L., a well-known genus comprising about 100 species distributed across Asia, Europe and North Africa, is one of the largest genera of Thymelaeaceae (ca. 45 genera, 1,000 species; Rogers 2009). Species of *Daphne* are deciduous or evergreen subshrubs, shrubs, or small trees, and are often cultivated as showy ornamentals (Brickell & Mathew 1976; Halda 2001). The genus is represented in India by eight species occurring in temperate Himalaya, Khasi Hills, and Manipur (Prasanna, pers. comm.; Rogers, unpubl. data). Most of the Indian species are relatively well-defined and easily distinguishable, but two putative relatives (*D. bholua* Buch.-Ham. ex D. Don and *D. papyracea* Wall. ex G. Don) pose difficult taxonomic problems (Burtt 1936). Both of these species are horticulturally important and belong to the "Paper Daphne" group (Brickell & Mathew 1976), as they are harvested for their bark, which is used to make paper and ropes (Hodgson 1832; Santapau & Henry 1973).

In the literature, *Daphne bholua* (recorded from India, Bangladesh, China, Bhutan, Myanmar, Nepal, Vietnam) and *D. papyracea* (recorded from India, China, Nepal) have most often been distinguished morphologically by differences related to leaf and bract persistence, flower color, fragrance, and hypanthium lobe shape (e.g., Brickell & Mathew 1976; Wang et al. 2007). The best documented distinction between the two species is whether or not the flowers are fragrant (sweetly-scented in *D. bholua* vs. odorless in *D. papyracea*). Differences in flower color have also been discussed in numerous treatments, but the supposed distinctions are often inconsistent or contradictory between reports (cf. Burtt 1936; Brickell & Mathew 1976; Halda 2001;

Wang et al. 2007). Flowers of *D. bholua* are generally described as pink, or white and flushed with either pink or purple, whereas flowers of *D. papyracea* are usually characterized as white, greenish-white, or rarely pinkish. Perhaps the apparent overlap in color variation does not occur throughout the entire geographic distribution of each species because in India the flowers of *D. bholua* are reportedly always pink and the flowers of *D. papyracea* are consistently pure white (Prasanna, pers. comm.). The two species are allopatric and probably inhabit different elevation ranges. *Daphne bholua* occurs in the foothills of the Eastern Himalayas, roughly from Arunchachal Pradesh to Darjeeling and West Bengal (Prasanna, pers. comm.), while *D. papyracea* is found in the mountains of the Western Himalayas, from approximately Western Nepal to Uttar Pradesh and Punjab (Brickell & Mathew 1976).

A total of eleven morphological variants have been formally named throughout the wide geographic ranges of both species (*Daphne papyracea*—two subspecies, eight varieties, one form; *D. bholua*—one subspecies, one variety). Some of the infraspecific taxa are now recognized at the species rank, while others have been reduced to synonymy under their respective species. Five of the varieties are still recognized (Wang et al. 2007), but only one, *D. bholua* var. *glacialis* (W.W. Sm. & Cave) B.L. Burtt, occurs in India (also recorded from China and Nepal). *Daphne bholua* var. *glacialis*, which was originally described as an extreme alpine variety of *D. cannabina* Lour. (Smith & Cave 1913), reportedly differs from *D. bholua* var. *bholua* by having deciduous (vs. more persistent) leaves (Burtt 1936; Halda 2001), less pubescent branchlets (Brickell & Mathew 1976), a creeping (vs. erect) habit, subrhombic (vs. semicircular) leaf scars, and 6–11 (vs. 11–16) pairs of lateral veins per leaf (Wang et al. 2007).

General palynological variation in Thymelaeaceae and *Daphne* pollen

The members of Thymelaeaceae constitute a remarkable stenopalynous assemblage of uniformly spheroidal grains (Mohl 1835) with polyforate (Blaise 1959) and panporate (Archangelsky 1966; cf. pantoporate - Punt et al. 2007) aperture types. The exine strata are formed by a highly specialized crotonoid tectum or a derivative thereof (Nowicke et al. 1985; Herber 2002). The "crotonoid pattern" of the exine was first defined by Erdtman (1952: 173) as being composed of "regularly arranged excrescences (triangular or ± circular in cross-section), supported (always?) by a baculate, baculoidate, or spongy layer." Individual subunits are attached to a basal ring-like network of muri (also known as horizontal rods). The shape of the subunits range from basic triangular to a number of other derived shapes (e.g., baculoidate, tetrahedral, pilate), thereby forming a homogenous or heterogeneous pattern over the surface of the exine.

Daphne pollen is classified as "Type IV," the most common of four categories of Thymelaeaceae pollen (Herber 2002). Archangelsky (1971) published the most comprehensive palynological investigation of *Daphne* using light microscopy, analyzing nearly one-half of the total number of species (ca. 40) in the genus. In that study, some species and groups of species were found to differ in one or more pollen characters (e.g., grain size, exine thickness, pore size, pore shape, pore number). Neither *D. bholua* nor *D. papyracea* have been investigated palynologically judging from available literature.

MATERIAL AND METHODS

One collection was selected for each of the three study taxa. Vouchers were identified by Dr. P. V. Prasanna, a specialist working in India, and specimens are deposited at CAL. For pollen extraction, between two and four anthers were removed from the mature buds of each collection, soaked for four to five hours in 70% alcohol, and then crushed on slides with one drop of distilled water. Extracted pollen grains were acetolyzed following the protocol of Erdtman (1960) and thoroughly washed with distilled water followed by ethanol. Excess ethanol was allowed to evaporate. Pollen grains were mounted on glass slides in glycerine jelly, sealed with molten paraffin wax, and observed with light microscopy (LM). For scanning electron microscopy (SEM) observations, one drop of the pollen-ethanol mixture was transferred to specimen stubs, any excess alcohol was allowed to evaporate, and pollen grains were sputter coated with a thin gold film of ca. 200 Å (at 18 mA current, 0.2 kV voltage for 160 sec.). Grains were viewed under the scanning electron microscope at an accelerating

voltage of 15 kV. Pollen size was measured using a calibrated ocular micrometer under LM. Palynological terminology was based on Erdtman (1952), Nair (1970), and Hesse et al. (2009).

RESULTS

General description of the observed pollen grains

Pollen grains monads, spheroidal, pantoporate, 17–32 μm in diameter. Wall tectate, suprareticulate with supratectal subunits of variable shapes and size; basal layer of ectoexine much thicker than endoexine; ectoexine attached to endoexine by means of columellae that unite to form supratectal projections (STP).

The STP correspond to the projections of the supratectal subunits described in the classification of Thymelaeaceae pollen published by Herber (2002).

Palynological summary of *Daphne bholua* var. *bholua*, *D. bholua* var. *glacialis*, and *D. papyracea* (Table 1; Fig. 1)

The pollen wall is formed by the primary and secondary reticulum, the latter is derived from a complete or partial fusion of supratectal elements. Supratectal elements form trihedral, dome-shaped or circular variously arranged supratectal subunits, which result in a crotonoid (*Daphne bholua* var. *bholua*), or barely detectable, semi-crotonoid pattern of supraornamentation (*D. bholua* var. *glacialis* and *D. papyracea*). The ectoexine is always thicker than the endoexine, and is attached to the endoexine by means of the columellae that unite to form the supratectum. The basic reticulate pattern is thus superimposed by the secondary reticulum of the supratectum and was previously described as cryptostellate by Archangelsky (1966, 1971), an observation that Herber (2002: 117) found to be erroneous. Grains are always spheroidal. Pollen size is small in *D. bholua* var. *bholua* (ca. 19.5 μm mean diameter) and larger in *D. bholua* var. *glacialis* and *D. papyracea* (both ca. 29 μm mean diameter). The supratectal subunits are either free (varying from densely to sparsely arranged), or fused in groups. When free, the individual subunits are distantly spaced, and the muri of the basal reticulum becomes exposed as horizontal rods. However, when these subunits are fused, the muri (i.e., horizontal rods) of the basal reticulum are concealed under the closely packed subunits. In all three taxa, the supratectal subunits are surmounted by a single, central projection (STP). The STP are spinulate and blunt in *D. bholua* var. *bholua*, verrucose and bead-like in *D. bholua* var. *glacialis*, and spinulate and sharply pointed in *D. papyracea*. The outlines and margins of the STP range from circular to angular and sinuous to rounded-angular, respectively, depending on the particular form of the STP.

PALYNOLOGICAL KEY TO TAXA

1. Pollen grain diameter less than 25 μm; STP fused in groups of 5–7; muri of basal reticulum concealed ________ **1a. Daphne bholua var. bholua**

1. Pollen grain diameter more than 25 μm; STP free, or sometimes fused in groups of 4–6; muri of basal reticulum exposed.
   2. STP baculoidate; subunits 4–6, free, or sometimes fused, sparsely arranged when free; projections verrucose, bead-like, and blunt ________ **1b. Daphne bholua var. glacialis**
   2. STP trihedral; subunits 5–6, free, densely arranged; projections spinulate and sharply pointed ________ **2. Daphne papyracea**

1. Daphne bholua Buch.-Ham. ex D. Don, Prodr. Fl. Nepal. 68. 1825.

1a. Daphne bholua var. **bholua** (**Fig. 1A–C**).

STP baculoidate (STP-B), flattened, mean size: 1 × 1.1 × 0.9 μm (height × base length × base width), size range: 1.0–1.2 × 1.1–1.2 × 0.9–1 μm; muri of basal reticulum concealed. Muri of secondary tectum forming groups of 5–7 subunits arranged in a crotonoid pattern, and surrounding the lumina of the basal (i.e., primary) reticulum; subunits densely packed, fused or rarely free. STP-B surmounted by minute, blunt spinules; spinule generally centrally located, sometimes displaced off-center, outline circular, margin sinuous; lumina of secondary reticulum 0.9–1 μm in diameter, rounded-angular.

Voucher specimen: **INDIA. Assam:** Shillong, 3000 ft, 25 Oct 1938, *K. Biswas 3733* (CAL).

1b. Daphne bholua var. **glacialis** (W.W. Sm. & Cave) B.L. Burtt, Bull. Misc. Inform. Kew 1936: 438. 1936. (**Fig. 1D–F**).

TABLE 1. Pollen morphology of the three study taxa. H: Height of projection; B_L: Base width for longest axis; B_S: Base width for shortest axis.

Pollen Feature	*D. bholua* var. *bholua*	*D. bholua* var. *glacialis*	*D. papyracea*
Full grain count	30	28	25
Sum total of counts	589	820	708
Mean grain diameter (μm)	19.5	29	29
Standard deviation in size	3	3	2
Aperture type	pantoporate	pantoporate	pantoporate
Muri of basal reticulum	concealed	exposed	exposed
Lumina of secondary reticulum diameter (μm)	0.9–1	0.6–1.8	1–2
Supratectal projections (STP)			
STP Shape	baculoidate, flattened (STP-B)	baculoidate, dome-shaped (STP-B)	trihedral, dome-shaped (STP-T)
Projections	spinulate, blunt	verrucose, blunt-beaded	spinulate, sharply pointed
STP pattern	crotonoid	semi-crotonoid	semi-crotonoid
Arrangement of subunits	fused, in groups of 5–7, rarely free, densely packed	4 and free, sparsely spaced, or 5–6 fused	5–6, free, densely packed
Outline/margin	circular/sinuous	irregularly angular/wavy	circular/rounded- angular
Mean size (μm) [$H \times B_L \times B_S$]	1 × 1.1 × 0.9	2.5 × 2.8 × 1.8	1.15 × 1.25 × 1.15
Height (H, μm)	1–1.2	2.4–2.6	1.1–1.2
Base-longest width (B_L, μm)	1.1–1.2	2.6–3.0	1.1–1.3
Base-shortest width (B_S, μm)	0.9–1.0	1.6–2.0	1.0–1.19

STP baculoidate (STP-B), dome-shaped, mean size: 2.5 × 2.8 × 1.8 μm (height × base length × base width), size range: 2.4–2.6 × 2.6–3 × 1.6–2 μm; muri of basal reticulum exposed as horizontal rods, ca. 0.8 μm wide. Muri of secondary tectum forming groups of 4–6 subunits and situated at the joining points of the muri of the basal reticulum; individual subunits 4 and free (distance between adjacent STP: 0.8–1.6 μm) or 5–6 fused, surrounding the lumina of the basal reticulum; arranged in a scattered semi-crotonoid pattern. STP-B surmounted by centrally located, circular, bead-like, verrucose projections, outline irregularly angular, straight-sided, margins wavy; lumina of secondary reticulum 0.6–1.8 μm in diameter, broadly angular.

Voucher specimen: **INDIA. Sikkim:** Jumlong, 6500 ft, 30 Apr 1876, *C.B. Clarke 27716* (CAL).

2. Daphne papyracea Wall. ex G. Don, Hort. Brit. 156. 1830. (**Fig. 1G–I**).
STP trihedral (STP-T), dome-shaped, mean size: 1.15 × 1.25 × 1.15 μm (height × base length × base width), size range: 1.1–1.2 × 1.1–1.3 × 1–1.19 μm; muri of basal reticulum exposed as horizontal rods, 0.3–0.9 μm wide. Muri of secondary reticulum (composed of the supratectum) forming groups of 5–6 subunits, arranged in a scattered semi-crotonoid pattern, surrounding the lumina of basal reticulum; subunits densely packed, free. STP-T surmounted by central, pointed, spinules, outline circular, margins rounded-angular; lumina of secondary reticulum 1–2 μm in diameter, unevenly rounded.

It should be noted that authors of modern taxonomic treatments (e.g., *Flora Malesiana*, Hou 1960; *Flore du Cambodge du Laos et du Viêtnam*, Hô 1992; *Flora of China*, Wang et al. 2007) have incorrectly credited Steudel (1840) as the validating author of *Daphne papyracea*, a name based on the illegitimate *D. cannabina* Wall. (1820), non Lour. (1790). Wallich's (1820) name was actually validated by George Don 10 years before Steudel's work in *Loudon's Hortus Britannicus* (Loudon 1830: 156) via the direct reference below *D. papyracea* to Wallich's name and description as "*Daphne cannabina* (sensu) Wall., Asiat. Res. 13:315 [typ. err. 385], ic. 1820 (non Lour. 1790)." To avoid unnecessary confusion regarding authorship, it should also be noted that Loudon, as editor of *Hortus Britannicus*, explicitly credited G. Don entirely for part I of the work (i.e., the "Linnean Arrangement"), which included the name *D. papyracea* (see page iv of the preface).

Voucher specimen: **INDIA. West Bengal:** Darjeeling, 6500 ft, 20 May 1949, *N. Narayanaswamy & Party 2770* (CAL).

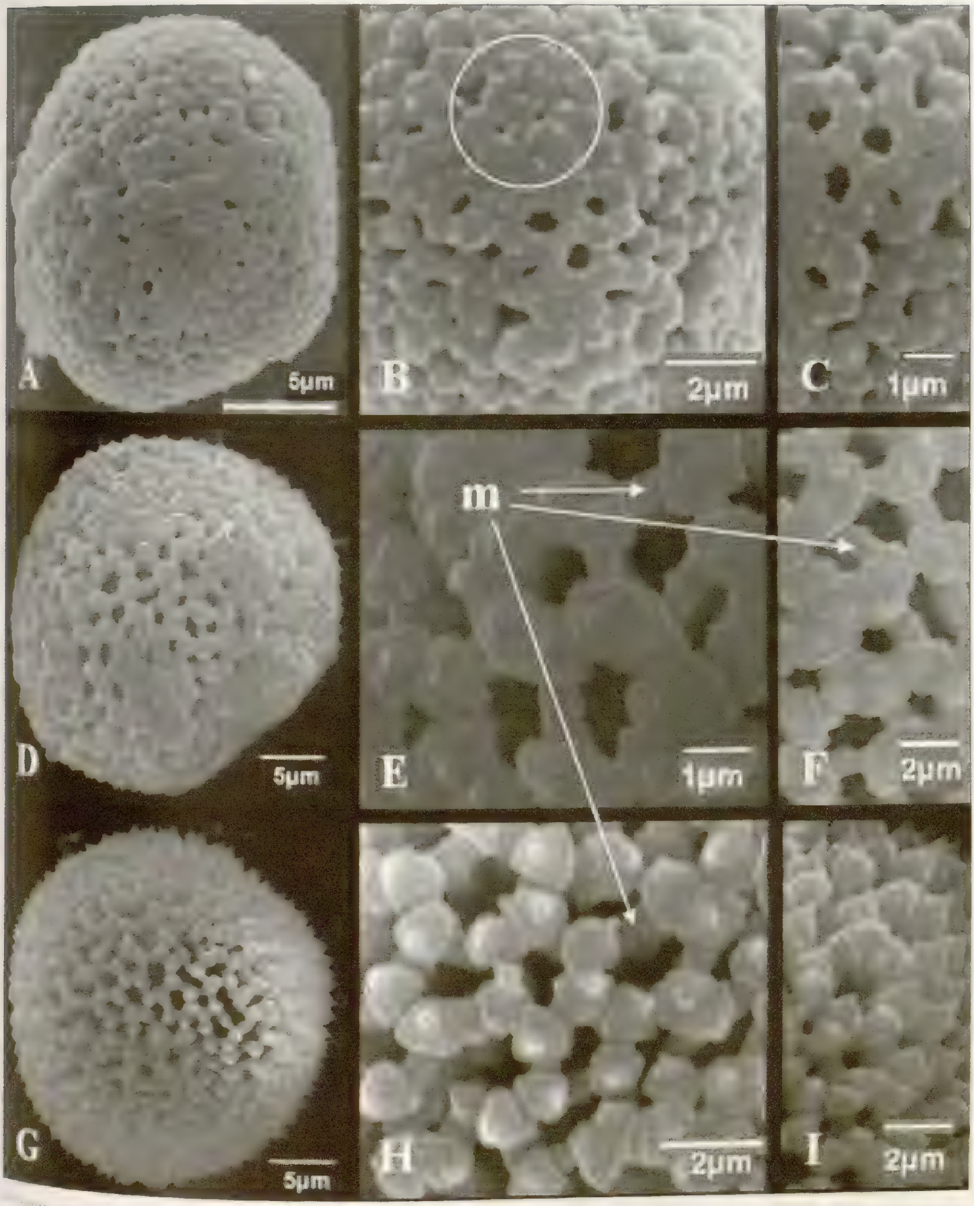

Fig. 1. Scanning Electron Micrographs of acetolyzed pollen (m: muri of basal reticulum). **A–C.** *Daphne bholua* var. *bholua*, **A.** Pollen grain, **B–C.** Surface with groups of fused supratectate projections surrounding lumina (encircled portion in B showing one unit of seven fused subunits). **D–F.** *Daphne bholua* var. *glacialis*, **D.** Pollen grain, **E–F.** Surface with free and fused groups of fused supratectate projections surrounding lumina. **G–I.** *Daphne papyracea*, **G.** Pollen grain, **H.** Surface with groups of supratectate projections surrounding lumina, **I.** Trihedral subunits with pointed spinule.

DISCUSSION

All three study taxa share a fundamentally similar exine structure formed by basic elements of regularly arranged excrescences (i.e., projections), which are supported by a baculate, baculoidate, or spongy layer of secondary (supra-) tectum. The resulting architecture forms the double reticulum and is a characteristic of Thymelaeaceae and Euphorbiaceae (Erdtman 1952). Pollen grains of Thymelaeaceae generally possess mural ridges that anastomose variously to form the horizontal rods of the basal reticulum and are surmounted by a very elaborate system of supratectal subunits (i.e., STP), which are organized into various patterns. These patterns display a wide range of variation in the arrangement, degree of fusion, shape, and size, and are of diagnostic value in the delineation of some taxa.

The morphological variation observed in several pollen grain characters (e.g., grain size, muri exposure, subunit arrangement, STP structure) allow all three study taxa to be distinguished palynologically (Table 1; Fig. 1). The baculoidate, dome-shaped STP of *Daphne bholua* var. *glacialis* pollen, is intermediate between the pollen of *D. bholua* var. *bholua* (STP baculoidate, flattened) and *D. papyracea* (STP trihedral and dome-shaped). The structure and arrangement of the STP in *D. bholua* var. *glacialis* with its semi-crotonoid pattern usually composed of free subunits (rarely fused) are characteristics of *D. papyracea*, whereas the presence of groups of 5–7 fused subunits (mixed with free subunits on the same pollen grain) is the usual form of *D. bholua* var. *bholua* pollen. Moreover, the mean pollen grain diameter was the same (29 µm) for *D. bholua* var. *glacialis* and *D. papyracea*, and both taxa have exposed muri of the basal reticulum. When taken together, the data suggest that *D. bholua* var. *glacialis* has a closer palynologic, if not taxonomic, affinity to *D. papyracea*. In addition to the novel pollen differences identified here, the three taxa differ in one or more readily available characters (e.g., floral scent, flower color, geographic distribution). Nevertheless, we refrain from taking formal nomenclatural action until our palynological results can be tested by further analyses utilizing additional pollen samples from more populations occurring throughout the widespread distributional ranges of all three taxa. So far none of the Paper Daphnes have been investigated using molecular phylogenetic analyses so it would also be worthwhile to add a DNA component to an expanded morphological study. Furthermore, future analyses of the Paper Daphnes would benefit from the inclusion of several more taxa such as *D. sureil* W.W. Sm. & Cave (recorded from India, Bangladesh, Bhutan, China, Nepal, Thailand), a putative relative, and the four currently recognized Chinese varieties of *D. papyracea*.

Lastly our palynological findings disagree with previous studies based on other genera of Thymelaeaceae, in which pollen was reportedly homogenous between species (e.g., Hawaiian *Wikstroemia*, Mayer 1991; *Lachnaea* – ca. 40 South African species, Beyers 2001), or variable in a few characters but still not deemed taxonomically useful at the species rank (e.g., *Passerina* – ca. 25 South African species, Bredenkamp & Van Wyk 1996).

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BOOK REVIEW

Alfred Richardson and Ken King. 2011. **Plants of Deep South Texas: A Field Guide to the Woody and Flowering Species.** (ISBN-13: 978-1-60344-144-5, pbk.). Texas A&M University Press, John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 800-826-8911). $30.00, 448 pp., 28 line drawings, 1,026 color photos, 7" × 10".

Plants of Deep South Texas is an essential field-guide to the botany of Cameron, Hidalgo, Willacy, and Starr counties (collectively known as the Lower Rio Grande Valley). The book covers more than three million acres of southernmost Texas and represents subtropic, temperate, coastal, and desert habitats comprising eleven distinct biotic communities. Over 800 species (excluding grasses) are described, accounting for about 77 percent of all species reported for this area. Perhaps, the most comprehensive photo-illustrated flora of the Lower Rio Grande Valley, the book also includes undescribed species, newly described species, the first published photographs of many species, and range extensions of many species, using the latest available taxonomy.

The book begins with a short introduction to the region and an illustrated guide to leaf shapes and flower parts. These sections are followed by the books individual species accounts that cover common and scientific names, habit, leaves, flowers, fruit, blooming period, and distribution. The plant species accounts are divided into algae, ferns, gymnosperms, monocots, and dicots. Also included for each species is the etymology of the scientific name, the use of the plant by larval butterflies, and species value from a human perspective. For each species there is at least one photo, and for some, two or three photos. The book ends with a glossary of terms, an index to butterfly and moth species mentioned in the text, a bibliography and a general index.

This book does not contain a key to families or species; rather it is designed to be a field reference for the plants of the Lower Rio Grande Valley. While the book is thick and heavy, the information contained within more than makes up for lugging it around in your backpack. Amateur naturalists, farmers, ranchers, and professional botanists alike will find this book quite useful for identifying the plants of southernmost Texas. I recommend this book to anyone working in South Texas.—*Kevin Janni, SWCA Environmental Consultants, 3901 Arlington Highlands Blvd, Suite 200, Arlington, TX 76018, kjanni@swca.com* and *Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

STUDY OF THE COMPARATIVE WOOD ANATOMY OF THE SPECIES OF AMPHOROGYNACEAE, CERVANTESIACEAE, NANODEACEAE, SANTALACEAE, AND THESIACEAE

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ABSTRACT

This work compares the anatomy of the secondary xylem of 56 species of 19 genera belonging to Amphorogynaceae, Cervantesiaceae, Nanodeaceae, Santalaceae, and Thesiaceae according to the new classification (Nickrent et al. 2010). Anatomical characters typical for each species were identified and two wood anatomical groups were recognized: Group A with vessel groupings with few solitary vessels, vessels in dendritic pattern (only *Jodina rhombifolia*, *Pyrularia*, *Myoschilos oblongum* and *Mida salicifolia*), long fibers with simple to bordered pits, vasicentric tracheids (except in *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Pyrularia* and *Scleropyrum*), fiber-tracheids (except in *Pyrularia*, *Okoubaka aubrevillei*, *Scleropyrum* and *Pilgerina madagascariensis*). Group B with solitary vessels, vasicentric tracheids, fiber-tracheids. Most species of Group A belong to Cervantesiaceae according to the new classification, except for the species of *Scleropyrum* that according to their anatomical characters belong to Group B. *Myoschilos oblongum* is part of Santalaceae (Group B) but anatomical characters are same as Cervanteciaceae. The wood anatomy of species in Group A shows more xeromorphic characters than the species of Group B. *Myoschilos oblongum* is adapted to cold regions where there is no water in the winter season.

RESUMEN

El presente trabajo compara la anatomía del xilema secundario de 56 especies de 19 géneros pertenecientes a Amphorogynaceae, Cervantesiaceae, Nanodeaceae, Santalaceae, y Thesiaceae de acuerdo a la nueva clasificación (Nickrent et al. 2010). Se identificaron caracteres anatómicos típicos para cada especie, pudiendose establecer dos grandes grupos de acuerdo a dichos caracteres: Grupo A con vasos agrupados y algunos solitarios, dispuestos de manera dendrítica (solamente en *Jodina rhombifolia*, *Pyrularia*, *Myoschilos oblongum* and *Mida salicifolia*), fibras largas con puntuaciones simples a rebordeadas, traqueidas vasicéntricas con paredes muy engrosadas y puntuaciones rebordeadas (excepto en *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Pyrularia* y *Scleropyrum*), fibro-traqueidas (excepto en *Pyrularia*, *Okoubaka aubrevillei*, *Scleropyrum* y *Pilgerina madagascariensis*). Grupo B con vasos solitarios, sin traqueidas vasicéntricas y con fibras liberiformes con puntuaciones simples. La mayoría de las especies del Grupo A pertenece a Cervantesiaceae segun la nueva clasificación, con excepción de las especies de *Scleropyrum* que de acuerdo con sus caracteres anatómicos pertenecen al Grupo B. *Myoschilos oblongum* es parte de Santalaceae (Grupo B), pero sus caracteres anatómicos son los mismos que Cervanteciaceae. La anatomía de la madera de las especies del Grupo A muestra más caracteres xeromórficos que las especies del Grupo B. *Myoschilos oblongum* está adaptada a regiones frías donde no hay agua en invierno.

INTRODUCTION

The objective of this paper is to provide new information about the wood anatomy of the species belonging to the families Cervantesiaceae Nickrent & Der, Thesiaceae Vest, Nanodeaceae Nickrent & Der, Amphorogynaceae (Stauffer ex Stearn) Nickrent & Der, and Santalaceae R. Br., with the aim of providing a better understanding of the relationships between these plants, according to the new classification of the order Santalales (Nickrent et al. 2010). This classification is based on results from molecular phylogenetic investigations and brings together currently available information that contributes to our understanding of relationships among these plants. The species studied are *Acanthosyris falcata, A. spinescens, and A. glabrata* of temperate South America; *Cervantesia tomentosa* of Andean South America; *Jodina rhombifolia* of southern Brazil, Uruguay, and Argentina; *Okoubaka aubrevillei* of tropical Africa; *Pilgerina madagascariensis* of Madagascar; *Pyrularia pubera* of the southeastern U.S. and *P. edulis* of India; *Scleropyrum walichianum and Scleropyrum maingayi* of India, southeast Asia, and Malesia; *Buckleya distichophylla* of eastern U.S.; *Thesium lineatum* of Namibia and South Africa; *Mida salicifolia* disjunct from New Zealand to the Juan Fernandez Islands; *Dendromyza reinwardtiana* of Papua New Guinea; *Dendrotrophe varians* from the Himalayas to the Philippines and Malaysia, Indonesia; *Colpoon compre-*

sum of South Africa; *Eubrachion ambiguum* of South America (Argentina, Uruguay, and south Brazil); *Exocarpos brachystachys, E. bidwillii, E. cupressiformis, E. vitensis* of southeast Asia and Malaysia to Hawaii; *Leptomeria billardieri* and *L. spinosa* of Australia; *Myoschilos oblongum* of Argentina and Chile; *Osyris* L., 6 species of Europe, Mediterranean, Africa, and China; and *Santalum* L., 16 taxa from Indomalaya to Australia and Hawaii.

MATERIALS AND METHODS

In total, 56 species of Cervantesiaceae Nickrent & Der, Thesiaceae Vest, Nanodeaceae Nickrent & Der, Amphorogynaceae (Stauffer ex Stearn) Nickrent & Der, and Santalaceae, representing 19 genera, were investigated using light microscopy (LM) and scanning electron microscopy (SEM).

Wood samples were available in dried condition. They were boiled in water, stored in 50% aqueous ethyl alcohol, and softened for 3 days in ethylenediamine (Kukachka 1977) prior to being sectioned; sections were prepared with a sliding microtome. Some sections were stained with safranin and counterstained with fast green before being mounted on slides. Other sections were dried between clean glass slides, sputter coated with gold, and examined with a scanning electron microscope. Macerations were prepared with Jeffrey's fluid (Jeffrey 1917) and stained with safranin-fast green combination.

All quantitative data are based on 25 measurements per feature. Terminology follows that of the IAWA Committee on Nomenclature (1964). For each sample, the collector name is listed first, followed by the wood collection number preceded by a code from Stern's *Index Xylariorum* (1988), and then the locality. The sources of the specimens studied are in Table 1 (some codes, localities and collectors are not known).

RESULTS

Descriptions of the anatomical characters are based on mature wood samples. A summary of selected anatomical features for the 56 species is shown in Table 2.

Growth ring boundaries generally indistinct or absent, but distinct growth rings observed in *Pyrularia pubera* (Fig. 1A), *Exocarpos bidwillii*, *Santalum spicatum* (Fig. 1B), *Buckleya distichophylla*, and *Myoschilos oblongum* (Fig. 1C).

Porosity diffuse in most of the species, except *Jodina rhombifolia* (Fig. 1D), *Pyrularia* (Fig. 1A), *Myoschilos oblongum* (Fig. 1C), and *Buckleya distichophylla* (Fig. 7E) semi-ring porous.

Vessels small to very small, average tangential diameter (20–100 µm). *Jodina rhombifolia* and *Leptomeria* have the narrowest vessels (20–22 µm) and *Scleropyrum* the widest (86 µm). Vessel element length is short (100–300 µm): *Leptomeria* (243 µm) had the longest vessel elements, followed by *Scleropyrum* (163 µm); *Myoschilos oblongum* (127 µm) had the shortest. *Scleropyrum* has the least number of vessels per mm^2 (12 vessels per mm^2) (Fig. 1E) and *Leptomeria* has the largest number of vessels per mm^2 (244 vessels per mm^2) (Fig. 1F).

Exclusively solitary vessels occur in most of the species (Fig. 1E, 2A), but *Acanthosyris* (Fig. 2B), *Okoubaka aubrevillei* (Fig. 7A), and *Mida salicifolia* (Fig. 2D) have vessels in radial multiples; *Cervantesia tomentosa* (Fig. 2C) and *Buckleya distichophylla* have vessels in short radial multiples and in clusters. *Myoschilos oblongum* is the only species of the Santalaceae that does not have exclusively solitary vessels and vessels occur in short radial multiples of 2–4 (Fig. 1C). *Mida salicifolia* has radial multiples of 4 or more and clusters (Fig. 2D).

Jodina rhombifolia (Fig. 1D), *Pyrularia* (Fig. 1A), *Myoschilos oblongum* (Fig. 1C), and *Mida salicifolia* (Fig. 2D) have vessels in dendritic pattern.

Simple perforation plates in all species; only rimmed perforation plates in *Buckleya distichophylla*, *Leptomeria*, and *Santalum hendersonense* (Fig. 2E). *Mida salicifolia* has a few scalariform perforation plates with 10–20 anastomosing bars (Fig. 2F).

Vessel outline was angular (Fig. 1F), circular (Fig. 3A) or oval (Fig. 3B) and the position of the perforation plates can be very oblique (Fig. 3C), oblique or horizontal (Fig. 3D) depending on each species.

Intervessel pits are opposite and/or alternate in all species (Fig. 3E). *Cervantesia tomentosa* and *Acanthosyris glabrata* have also polygonal alternate pits (Fig. 3F). *Dendromyza reinwardtiana*, *Myoschilos oblongum*, *Thesium*

TABLE 1. Sources of specimens studied. Collector's name/no. is listed first, followed by the wood collection number preceded by a code from Stern's *Index Xylariorum* (1988), and locality.

Taxon	Collector & No.	Index Xylariorum Code	Locality
Acanthosyris glabrata (Stapf) Stauffer	Dugand s.n.	(SJRw 27095)	Colombia
	Dugand s.n.	(SJRw 28474)	Colombia
	Dugand s.n.	(SJRW 29686)	Colombia
	Dugand s.n.	(SJRw 32393)	Colombia
Acanthosyris falcata Griseb.	Venturi 952	(LILw)	Tucumán Prov., Argentina
		(SJRw 1113)	Argentina
	Novarrez s.n.	(SJRw 15012)	Buenos Aires Prov., Argentina
Acanthosyris spinescens	División Forestal	(Baw)	Argentina
(Mart. & Eichler) Griseb.	Norverto 16, 17, 18	(BAw)	Entre Ríos Prov., Argentina
Buckleya distichophylla (Nutt.) Torr.	L.J. Musselman		Virginia, U.S.A.
Cervantesia tomentosa Ruiz & Pav.	A. Dugand s.n.	(SJRW 28474)	Colombia
	A. Dugand s.n.	(SJRW 29686)	Colombia
	A. Dugand s.n.	(SJRW 32393)	Colombia
Colpoon compressum P.J. Bergius	Pappe s.n.	(Kw 15407)	South Africa
Dendromyza reinwardtiana (Blume ex Korth.) Danser	B. Hyland 9519, Susanne Kaplan s.n.	(SMHI 1739)	
Dendrotrophe varians Miq.		(DLN 4017)	
Eubrachion ambiguum (Hook. & Arn.) Engl.	Nickrent 2699		
Exocarpos bidwillii Hook. f.	Carlquist 5545		
Exocarpos brachystachys Hillebr.	Carlquist 1899	(USw 38946)	Hawaii, U.S.A.
	Forbes s.n.	(SJRw 26283)	W. Maui, Hawaii, U.S.A.
Exocarpos cupressiformis Lab.		(Kw 15416)	Victoria, Australia
		(USw 949)	New South Wales, Australia
		(SJRw 19446)	New South Wales, Australia
	Div. of Forest Products	(SJRw 33466)	Victoria, Australia
Exocarpos vitensis A.C. Sm.	Col. A.C. Simth s.n.	(USw 30483)	Fiji
Jodina rhombifolia Hook. & Arn.	Mantese s.n.	(BAw 55899, 55901, 55903)	Chaco Prov., Argentina
	Venturi 388b	(LILw)	Tucumán Prov., Argentina
	Cozzo s.n.	(Baw 52256)	Córdoba Prov., Argentina
	Norverto 20, 21, 22	(BAw)	Buenos Aires Prov., Argentina
	Del Vitto 994	(Baw)	San Luis Prov., Argentina
	Schuel s.n.	(Kw 15425)	northern Argentina
		(Usw 4184)	Catamarca Prov., Argentina
Leptomeria billardieri R. Br.	Walker s.n.	(Kw 15427)	Hobart, Tasmania
Leptomeria spinosa A. DC.		(DLN 3081)	
Mida salicifolia A. Cunn. (= *Fusanus cunninghamii* Benth. et Hook.		(USw W13905)	New Zealand. DLN 4307
Myoschilos oblongum Ruìz et Pav.	Brion s.n.	(BAw 144)	Río Negro Prov., Argentina
	Rotkugel s.n.	(SJRw 1744)	Patagonia, Argentina
	Bullock s.n.	(Usw 15356)	Chile. DLN 4504B
Okoubaka aubrevillei Pellegr. & Normand		Xylariorum 158	Odii, Ghana, Africa
Osyris abyssinica Hochst.		(SJRw 31899)	East Africa
		(MADw 4856)	South Africa
Osyris alba L.	Playfair s.n.	(Kw 15428)	Algeria
Osyris lanceolata Hochst. & Steud.		(PFPw 5143)	Pretoria, South Africa
Osyris lanceolata Hochst. & Steud. (= *Osyris quadripartita* Salzm. ex Decne	Schweingruber s.n.	(SMHI s.n.)	Murcia, España
Osyris tenuifolia Engl.		(USw V11836)	Tanganyika, East Africa
Osyris wightiana Wall.		(SJRw 29410)	Kilimandscharo, Tanganyika, East Africa
Pilgerina madagascariensis Z.S. Rogers, Nickrent & Malécot	Rabenatoandro et al. 315A		
Pyrularia edulis A. DC.		(Kw 15431)	Darjeeling, India
Pyrularia pubera Michx.		(MADw 15725)	West Virginia, U.S.A.
Santalum album L.		(Kw 15434)	Mysore, India
		(USw 37761)	India

Table 1. Continued.

Taxon	Collector & No.	Index Xylariorum Code	Locality
Santalum austrocaledonicum Vieill.		(USw w4760)	New Caledonia
		(SJRw 13991)	
		(SJRw 14316)	
Santalum cuneatum Rock		(SJRw 29753)	Hawaii, U.S.A.
Santalum ellipticum Gaud.		(SJRw 1902)	
Santalum fernandezianum F. Phil.	Meyer s.n.	(USw 34036)	Juan Fernandez Islands
Santalum freycinetianum Gaud.	Carlquist 1918	(USw 38950)	Hawaii, U.S.A.
		(SJRw 1902)	Hawaii, U.S.A.
	Carlquist	(USw 15344)	
	Carlquist 598 (RSA)		
Santalum freycinetianum var. **pyrularium** (Gray) L. Stemmermann	Stern & Carlquist 1278	(USw 25976)	
	522 (RSA)		
Santalum freycinetianum var. **lanaiense** Rock		(SJRw 26249)	
Santalum haleakalae Hillebr.	Carlquist 548	(USw 15319)	Maui, Hawaiian Islands
Santalum hendersonense F. Br.	Bishop s.n.	(SJRw 37304)	Hendreson Is.
Santalum insulare var. **raiateense** (J. Moore) Fosberg & Sachet		(SJRw 24861); (SJRw 24295)	
Santalum insulare var. **marchionense** (Skottsb.) Skottsb.		(SJRw 24369)	
Santalum lanceolatum R. Br.		(Usw 21172)	
Santalum paniculatum Hook. & Arn.		(USw w5630)	Hawaiian Islands
Santalum yasi Seem.		(USw30349)	
Santalum spicatum A. DC. = *Eucarya spicata* (R. Br.) Spr. et Summerh	F. du s.n.	(Kw 15409)	Western Australia
		(Kw 15424)	Western Australia
	Baron F. von Mueller s.n.	(Kw 15412)	S.W. Australia
	Forestry Commission s.n.	(USw 22403)	Western Australia
		(USw 4031)	Western Australia
		(USw W-8802)	Western Australia
Scleropyrum walichianum Ait.	Wright	(Kw 15452)	Ceylon
	Ridsdale 485	(USw s.n.)	South India
Scleropyrum maingayi Hook. f.		(USw 28364)	
Thesium lineatum L.f.		(RSA 4627a)	South Africa

lineatum, and *Mida salicifolia* also have scalariform intervessel pits (Fig. 4A). Apertures are sometimes coalescent (Fig. 3E; 4B).

Vessel-ray pits are of two distinct sizes and types in the same ray cell, distinctly bordered pits and other large pits with much reduced borders to apparently simple, pits rounded (Fig. 4C). There are also vessel-ray pits with distinct borders, similar to intervessel pits (Fig. 4D). Vessel-ray pits with much reduced borders to apparently simple; pit outline rounded present in *Okoubaka aubrevillei* (Fig. 7B). *Acanthosyris glabrata* has vessel-pits unilaterally compound and coarse (Norverto 1993).

Tails are present or absent on vessels. Various species have helical thickenings in vessel elements (Fig. 4E). Vessel walls helically thickened and vestured in *A. spinescens* (Norverto 1993). There are also species with unusual thickenings surrounding vessel pits (Metcalfe & Chalk 1950; Patel 1974) (Fig. 4F). Some species have tyloses (Fig. 1B).

Parenchyma. Most of the species have diffuse apotracheal axial parenchyma (Fig. 1E). Some species of *Exocarpos*, *Santalum*, and *Okoubaka aubrevillei* have diffuse in aggregates axial parenchyma (Fig. 5A; 7A). Absence of axial parenchyma was observed in *Buckleya distichophylla* (Fig. 7 F), *Osyris alba*, and *O. wightiana*. Generally, the species have scanty paratracheal axial parenchyma. *Acanthosyris glabrata*, *Osyris alba*, *O. lanceolata* and *O. wightiana* have axial parenchyma confluent (Fig. 5B). *Acanthosyris falcata* and *Cervantesia tomentosa*

TABLE 2. Overview of selected wood anatomical characters within species of Amphorogynaceae, Cervantesiaceae, Nanodeaceae, Santalaceae, and Thesiaceae.

Family/Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Cervantesiaceae																									
Acanthosyris glabrata	1	2	2	1	0&1	1	1	1	1	1	0	1	1	2	1	0	2	0	0&1	0	2	0	0&1	1	0
Acanthosyris falcata	1	2	2	1	0&1	1	0	1	1&2	0	0	1	1	1	1	0	1	1	0&1	0	0	1	0&1	1	0
Acanthosyris spinescens	1	2	2	1	0&1	1	1	1	2	0	0	1	1	1	1	0	1	0	1	0	0	1	0	0	1
Cervantesia tomentosa	1	2	2	1&2	0	1	1	0&1	1	0	0	1	1	2	1	0	1	1	0	1	1	0	0&1	1	0
Okoubaka aubrevillei	1	2	2	1&2	1	0&1	0	1	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0&1	0	1
Jodina rhombifolia	1	1	3	1&2	0	0	1	0	0	0	0	1	1	0&1	1	0	1	0	0&1	0	1	1	0	1	1
Pyrularia edulis	1	2	3	1&2	0	0	1	1&2	0	0	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0
Pyrularia pubera	0	1	3	1&2	0	0&1	1	1&2	0	0	0	0	1	1	1	0	1	0	0	1	0	0	0	0	0
Scleropyrum walichianum	1	2	0	0	1	1	0	1	0	0	0	0	1	1	1	1	1	0	1	0	1	0	0	1	0
Scleropyrum ridleyi	1	2	0	0	1	1	0	1	0	0	0	0	1	1	1	0	1	0	1&2	0	1	1	0	1	0
Scleropyrum maingayi	1	2	0	0	1	1	0	1	0	0	0	0	1	1	1	1	1	0	1&2	0	0	1	0	1	0
Pilgerina madagascariensis	1	2	0	0	1	0&1	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0	0	0	0	1
Amphorogynaceae																									
Dendromyza reinwardtiana	1	2	0	0	1	1	1	2	1	0	1	1	0	0	1	0	1	0	0&1	1	0	0	0	1	1
Dendrotrophe varians	1	2	0	0	1	1	1	2	1&2	0	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0
Leptomeria billardieri	1	2	1& 2	0&1	0	0&1	0	0	1&2	0	1	1	0	0	1	0	1	0	0&1	1	2	1	0	0	0
Leptomeria spinosa	1	2	1& 2	0&1	0	0&1	0	0	1&2	0	1	1	0	0	1	0	1	0	0&1	1	2	1	0	0	0
Santalaceae																									
Colpoon compressum	1	2	0	0	0&1	1	0	0&1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1	0
Eubrachion ambiguun	1	2	0	0	0	0&1	0	0&1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0
Exocarpos brachystachys	1	2	0	0	0&1	0&1	0	0&1	1&2	0&1	1	1	0	0&1	1	0&1	1	0	0	0	0	0	0	1	0
Exocarpos cupressiformis	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	0	0	0	1&2	1	0
Exocarpos bidwillii	0	2	0	0	0&1	0&1	1	0&1	2	0	1	1	1	0	1	0&1	1	0	0&1	0	0	1	1&2	1	0
Exocarpos latifolius	1	2	0	0	0	0&1	0	0&1	1	0	1	1	0	0&1	1	0	1	0	0	0	0	1	1	1	0
Exocarpos vitensis	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	0	0	0	0	1	0
Myoschilos oblongum	0	1	3	1	0	0	1	0	0&1&2	0	1	1	1	0	1	0	1	0	1	0	2	1	0	0	0
Osyris abyssinica	1	2	0	0	0&1	1	0	0&1	1&2	0&1	1	1	0	0&1	1	0	1	0	0	0	0	1	0	0	0
Osyris alba	0	2	0	0	0&1	0	1	0	2	0	1	1	0	0	0	0	0	0	0&1	0	2	0	0	0	0
Osyris lanceolata	1	2	0	0	0&1	0&1	0&1	0&1	1&2	0	1	1	0	0&1	1	0	0&1	0	0	0	2	0	0	0	0
Osyris tenuifolia	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0	1	0	0	0	2	0	0	1	0
Osyris wightiana	1	2	0	0	0&1	1	0	0&1	1&2	0	1	1	0	0&1	0	0	0	0	0	0	0	0	0	0	0
Santalum album	1	2	0	0	1	1	1	0&1	1&2	0&1	1	1	0	0&1	1	0&1	1	0	0&1	0	0	0	1	1	0
Santalum insulare var. *raiateense*	1	2	0	0	1	1	0	0	1&2	1	1	1	0	0	1	0&1	1	0	0	0	0	0	1	1	0
Santalum insulare var. *marchionense*	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	0	0	0	0	1	0
Santalum austro-caledonicum	1	2	0	0	1	0&1	1	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	0	0	0	1	1	0
Santalum cuneatum	1	2	0	0	1	0&1	0	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	1	0	0	1	1	0
Santalum fernandezianum	1	2	0	0	1	1	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0
Santalum freycinetianum	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0	1	0	0	0	0	0	1	1	0

Table 2. Continued.

Family/Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Santalaceae (cont.)																									
Santalum freycinetianum var. *pyrularium*	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0&1	1	0	0	0	0	0	0	1	0
Santalum freycinetianum var. *lanaiense*	1	1	0	0	0&1	1	0	0&1	1&2	0	1	1	0	0&1	1	0	1	0	0	0	0	0	0	1	0
Santalum haleakalae	1	2	0	0	0&1	1	1	0	2	0	1	1	0	0	1	0	1	0	0	0	0	0	1	1	0
Santalum hendersonense	1	2	0	0	0&1	1	0	0&1	1&2	0	1	1	0	0&1	1	1	1	0	0	0	0	0	1	1	0
Santalum paniculatum	1	2	0	0	1	1	0	1	1	0	1	1	0	1	1	0	1	0	0	0	0	0	1	1	0
Santalum pyrularium	1	2	0	0	1	1	0	0	1	0	1	1	0	1	1	0&1	1	0	0	0	0	0	0	1	0
Santalum spicatum	1	2	0	0	0	1	0	0&1	1&2	0	1	1	0	0&1	1	0	1	0	0	0	0	0	1	1	0
Santalum yasi	1	2	0	0	1	1	0	0&1	1&2	0	1	1	0	0&1	1	0	1	0	0	0	0	0	0	1	0
Santalum ellipticum	1	2	0	0	0&1	1	0	0&1	1&2	0	1	1	0	0	1	0&1	1	0	0	0	0	0	0	1	0
Santalum spicatum (R. Br.) A. DC. (=*Eucarya spicata*)	0	1	0	0	0	1	1	1	2	0	1	1	0	0	1	0	1	0	0	1	2	1	1	0	0
Thesiaceae																									
Buckleya distichophylla	0	0	3	0&1&2	0	1	0	0	2	1	1	1	0	0&1	0	0	0	0	0&1	0	0	0	0	0	0
Thesium lineatum	1	2	0	1	0	1	0	0	2	0	1	1	0	0&1	1	0	1	0	0	0	2	0	1	0	0
Nanodeaceae																									
Mida salicifolia A. Cunn (= *Fusanus cunnighamii*)	1	2	2&3	1&2	0	0&1	1	0	2	1	1	1	1	1	1	0&1	1	2	0	0	0	0	1	0	0

GROWTH RING—**1. Growth ring:** 0- boundaries distinct; 1- boundaries indistinct or absent.

VESSELS—**2. Porosity:** 0- Wood ring-porous, 1- Wood semi-ring-porous, 2- Wood diffuse-porous. **3. Vessel arrangement:** 0- absent, 1- in tangential bands, 2- in diagonal and/or radial pattern, 3- in dendritic pattern. **4. Vessel grouping:** 0- exclusively solitary (90% or more), 1- in radial multiples, 2- clusters common. **5. Solitary vessel outline:** 0- angular, 1- circular or oval. **6. Perforation plate position:** 0- very oblique, 1- slightly oblique or horizontal. 7. **Helical thickenings:** 0. absent, 1- present in vessel elements. **8. Mean tangential diameter of vessel lumina:** 0- ≤ 50 µm, 1- 50-100 µm, 2- 100–200 µm. **9. Vessels per square mm:** 0- 5–20 per mm^2, 1- 20–100 per mm^2, 2- ≥ 100 per mm^2. **10. Mean vessel element length:** 0- ≤ 350 µm, 1- 350–800 µm.

TRACHEIDS AND FIBERS—**11-Vascular/vasicentric tracheids:** 0- Absent, 1- Present. **12. Fiber-tracheids:** 0- absent, 1- present. **13. Fibers:** 0- absent, 1- present. **14. Mean fibers lengths:** 0- ≤ 900 µm, 1- 900–1600 µm, 2- ≥ 1600 µm.

AXIAL PARENCHYMA—**15- Axial parenchyma:** 0- absent or extremely rare, 1- present. **16. Apotracheal axial parenchyma:** 0- diffuse, 1- diffuse in aggregates. **17. Paratracheal axial parenchyma:** 0- absent, 1- scanty paratracheal, 2- confluent. 18. **Axial parenchyma banding:** 0- absent, 1- bands more than three cells wide, 2- in narrow bands or lines up to 3 cells wide.

RAYS—**19. Ray width:** 0- 1 to 3 cells, 1- 4 to 10-seriate for larger rays, 2- > 10-seriate for larger rays. **20. Ray with multiseriate portion(s) as wide as uniseriate portions:** 0- absent, 1- present. **21. Ray height:** 0- ≤ 1mm, 1- > 1 mm, 2- of two distinct sizes. **22. Perforated ray cells:** 0- absent, 1- present. **23. Rays per mm:** 0- ≤ 4/mm, 1- 4–12 / mm, 2- ≥ 12 / mm.

MINERAL INCLUSIONS—**24. Prismatic crystals:** 0- absent, 1- present. **25. Druses:** 0- absent, 1- present.

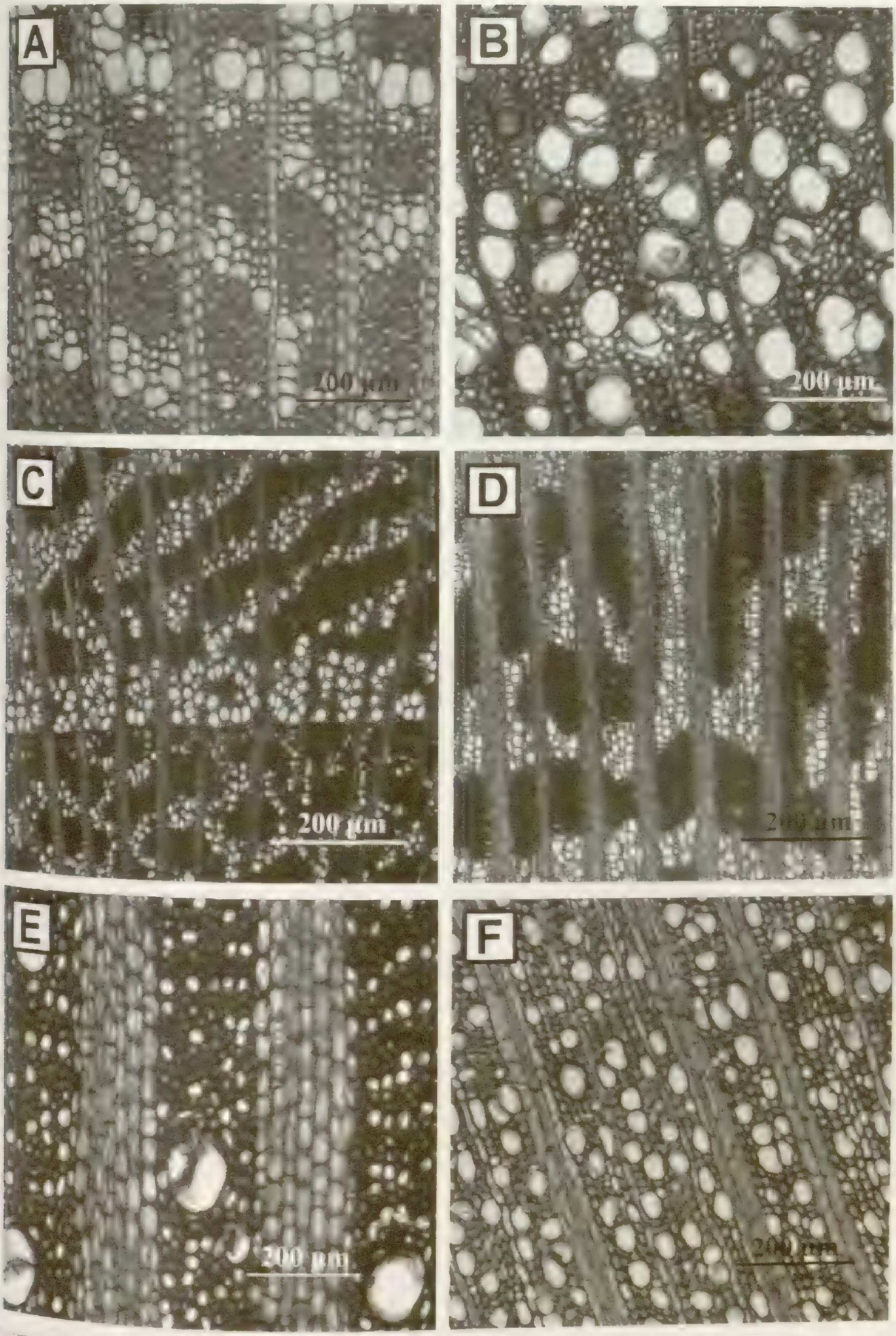

FIG. 1. LM micrographs of the wood structure in Santalaceae. **A**, *Pyrularia pubera*, growth ring boundaries distinct and wood ring-porous, vessels in dendritic pattern, transverse section (TS); **B**, *Santalum spicatum*, growth ring boundaries indistinct, tyloses in vessels, TS; **C**, *Myoschilos oblongum*, growth ring boundaries distinct and wood ring-porous and to semi-ring-porous, vessels in diagonal to dendritic pattern, TS; **D**, *Jodina rhombifolia*, vessels in dendritic pattern, TS; **E**, *Scleropyrum walichianum*, solitary vessel outline oval, axial parenchyma diffuse, and wide rays, TS; **F**, *Leptomeria billiardieri*, solitary vessel outline angular, TS.

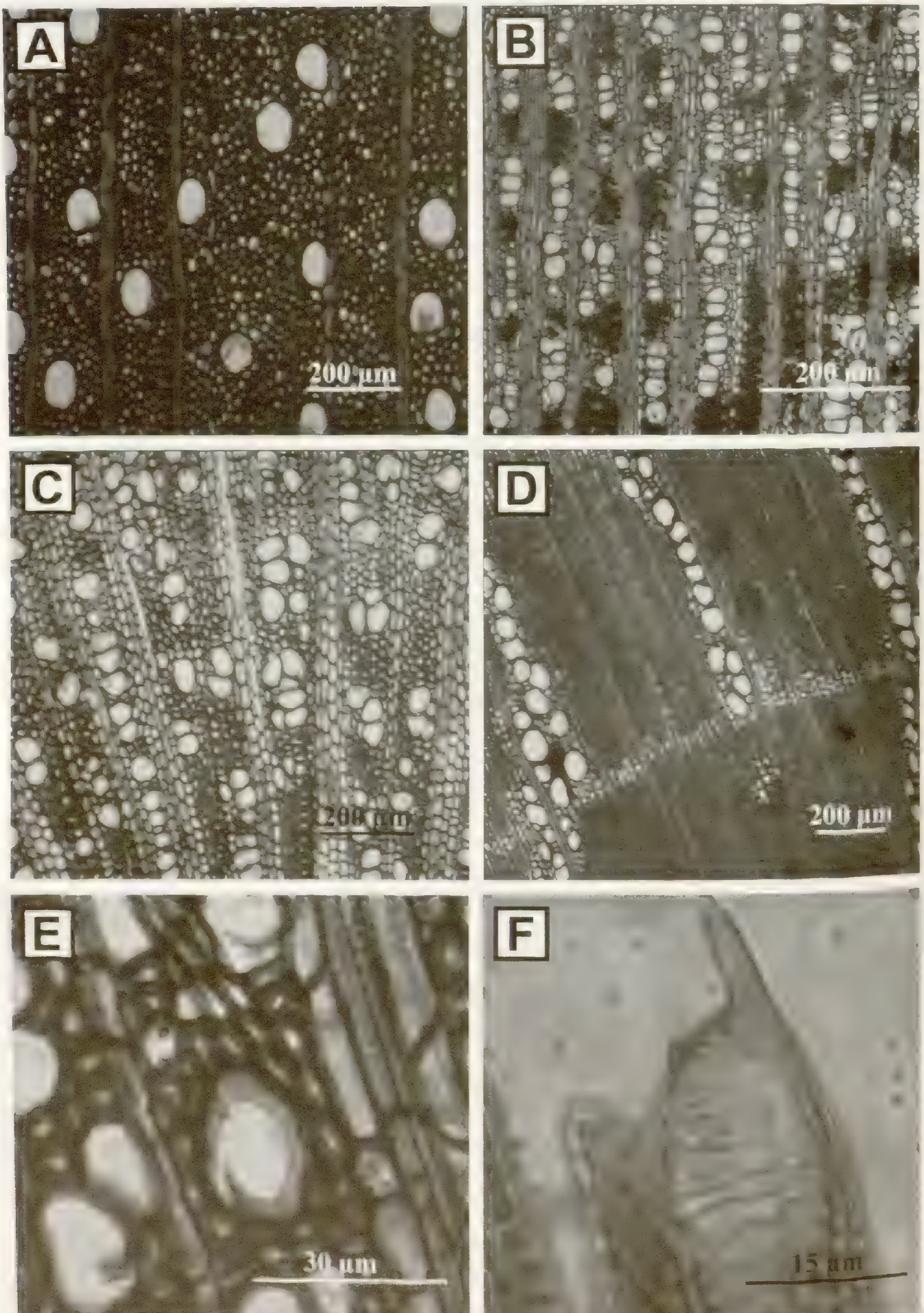

FIG. 2. LM micrographs of the wood structure in Santalaceae. A, *Santalum freycinetianum* var. *pyrularium*, solitary vessel outline oval, TS; B, *Acanthosyris spinescens*, vessels in radial multiples, TS; C, *Cervantesia tomentosa*, vessels in radial multiples, TS; D, *Mida salicifolia*, vessels in radial dendritic pattern TS; E, *Leptomeria billardieri*, rimmed perforation plate, TS; F, *Mida salicifolia*, scalariform perforation plate, maceration.

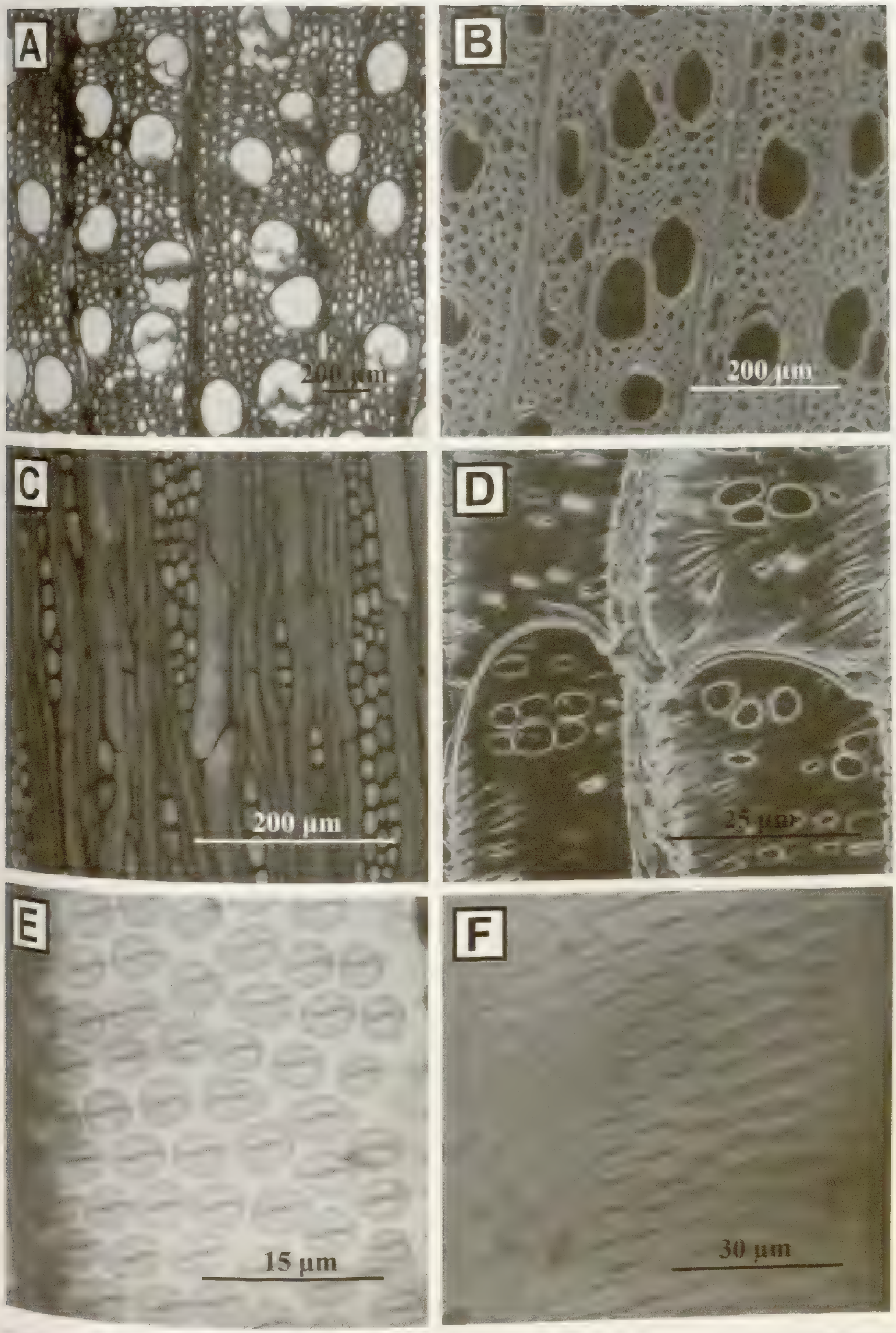

FIG. 3. LM micrographs (A–C–F) and SEM micrographs (B–D) of the wood structure in Santalaceae. **A,** *Santalum insulare* var. *raiateense*, solitary vessel outline circular, TS; **B,** *Osyris abyssinica*, solitary vessel outline oval, TS; **C,** *Leptomeria billarderi*, perforation plates oblique, tangential longitudinal section (TLS); **D,** *Acanthosyris spinescens*, perforation plates horizontal and pits with borders greatly reduced to very nearly simple, radial longitudinal section (RLS); **E,** *Acanthosyris falcata*, intervessel pits alternate, RLS; **F,** *Acanthosyris glabrata*, intervessel pits, shape of alternate pits polygonal, TLS.

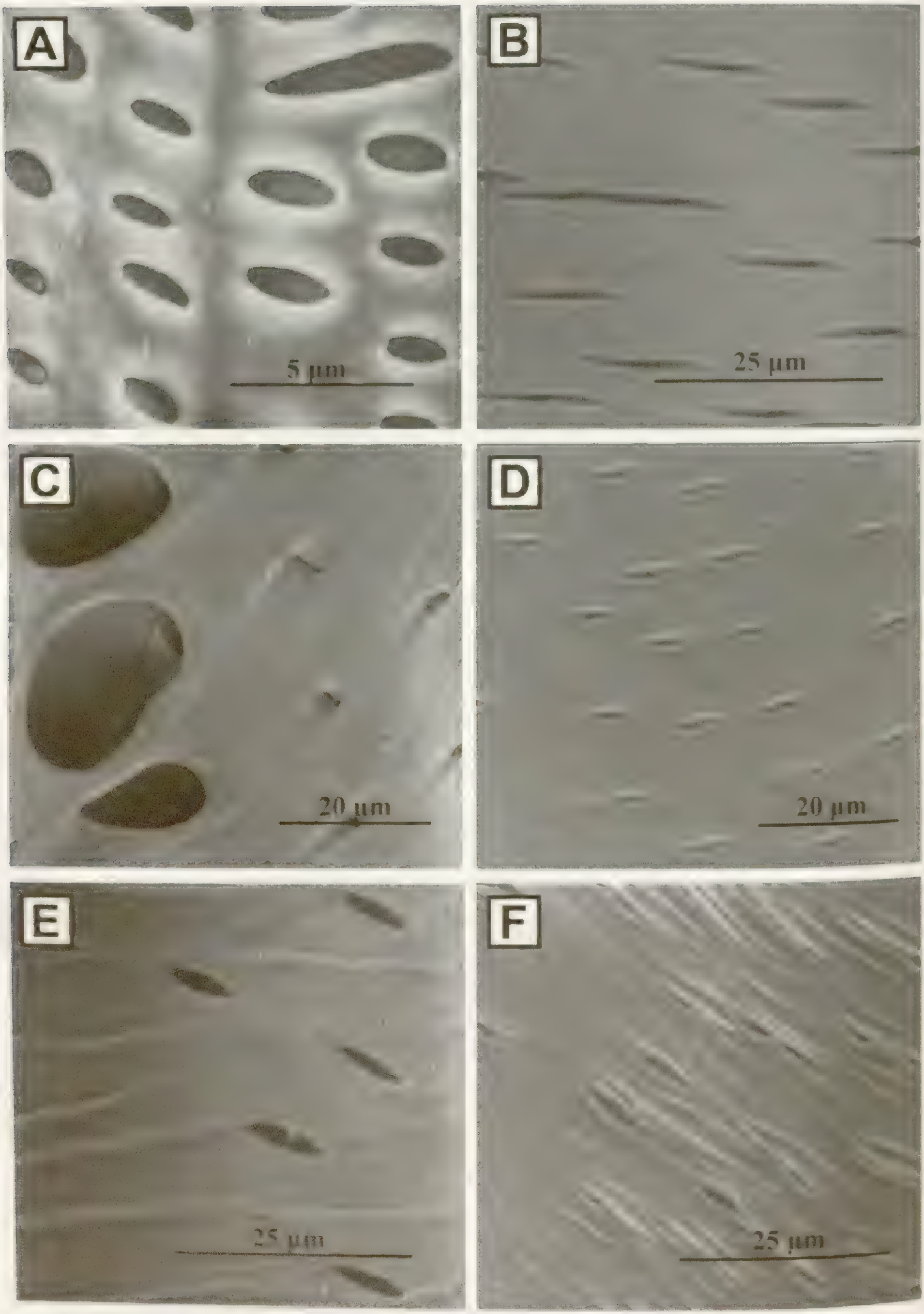

FIG. 4. SEM micrographs of the wood structure in Santalaceae. **A**, *Myoschilos oblongum*, intervessel pits scalariform, RLS; **B**, *Santalum album*, included and coalescent apertures; **C**, *Cervantesia tomentosa*, vessel-ray pits of two distinct sizes and types in the same ray cell, TLS; **D**, *Santalum freycinetianum* var. *lanaiense*, vessel-ray pits with distinct borders, similar to intervessel pits in size, RLS; **E**, *Pyrularia edulis*, helical thickenings in vessel element, TLS; **F**, *Santalum insulare* var. *raiateense*, thickenings around bordered pits, RLS.

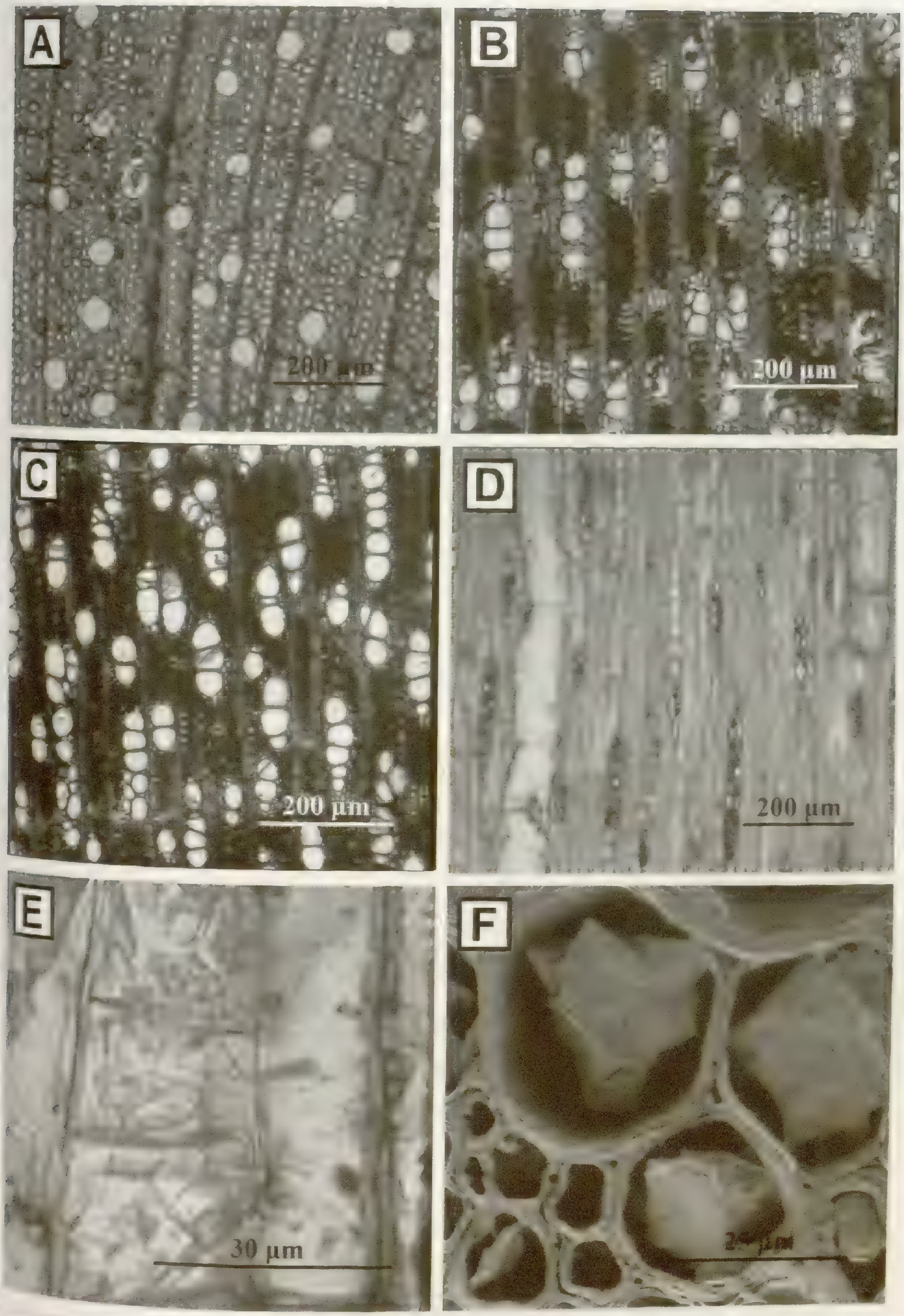

FIG. 5. LM micrographs (A–E) and SEM micrographs (F) of the wood structure in Santalaceae. **A,** *Exocarpos brachystachys*, solitary vessels, axial parenchyma diffuse-in-aggregates, TS; **B,** *Acanthosyris glabrata*, vessels commonly in radial multiples, axial parenchyma confluent, TS; **C,** *Acanthosyris falcata*, parenchyma axial bands and scanty paratracheal parenchyma, TS; **D,** *Exocarpos vitensis*, narrow rays, prismatic crystal in chambered axial parenchyma cells, TLS; **E,** *Dendromyza reinwardtiana*, druses in axial parenchyma cells, RLS; **F,** *Dendromyza reinwardtiana*, druses in axial parenchyma cells, TS.

have axial parenchyma bands with more than 3 cells wide (Fig. 5C). *Mida salicifolia* has axial parenchyma narrow bands from 1 to 2 cells wide (Fig. 2D).

Parenchyma of the species is usually 2 to 4 cells per parenchyma strand. Fusiform parenchyma cells are found in *Scleropyrum walichianum* and *Eubrachion ambigunn*. *Acanthosyris*, *Okoubaka aubrevillei*, *Dendrotrophe varians*, *Exocarpos*, *Santalum yasi*, and *Mida salicifolia* have 5 or more parenchyma cells per strand. In *Acanthosyris* and *Cervantesia tomentosa*, disjunctive axial parenchyma cell walls were observed.

Prismatic crystals in axial parenchyma cells of *A. glabrata*, *Dendromyza reinwardtiana* and *Colpoon compressum*. Prismatic crystals in chambered axial parenchyma cells of *Exocarpos brachystachys*, *E. cupressiformis*, *E. latifolius*, *E. vitensis*, and *Santalum* (Fig. 5D). Druses in axial parenchyma cells of *Acanthosyris spinescens*, *Dendromyza reinwardtiana*, and *Pilgerina madagscariensis* (Fig. 5E, F). Crystals in idioblasts were observed in *Colpoon compressum* and *Santalum spicatum*.

Rays usually 1 to 3 cells wide. Rays 4 to 10 cells wide in *Acanthosyiris*, *Buckleya distichophylla*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Scleropyrum*, *Exocarpos bidwillii*, *Myoschilos oblongum*, *Osyris alba*, and *Santalum album* (Fig. 6A). *Scleropyrum maingayi* and *S. walichianum* may have rays more than 10 cells wide (Fig. 1E).

Dendromyza, *Dendrotrophe*, *Leptomeria*, *Pyrularia*, *Santalum spicatum*, and *Santalum cuneatum* have rays with uniseriate portions as wide as multiseriate portions (Fig. 6B). *Okoubaka aubrevillei* has rays with procumbent body cells and over 4 rows of upright marginal cells (Fig. 7C). Aggregate rays were only observed in *Cervantesia tomentosa* (Fig. 6C). Type heterogeneous (Kribs II) to homogeneous (Kribs I). All species have rays irregularly storied (Fig. 6D).

Perforated rays cells in *Acanthosyris falcata*, *A. spniescens*, *Scleropyrum*, *Leptomeria*, *Exocarpos latifolius*, *E. bidwillii*, *Myoschilos oblongum*, *Osyris abyssinica*, *Pyrularia*, and *Santalum spicatum* (Fig. 6E) (Rao et al. 1984).

Prismatic crystals in ray parenchyma cells in *Acanthosyris falcata*, *A. glabrata*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Scleropyrum*, *Dendromyza reinwardtiana*, *Dendrotrophe varians*, and *Osyris tenuifolia* (Fig. 6F). Prismatic crystals in chambered ray parenchyma cells in *Dendrtrophe varians*. Druses in ray parenchyma cells present in *Jodina rhombifolia* (Norverto 1993) and *Okoubaka aubrevillei* (Fig. 7D).

Libriform fibers present in *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Pyrularia*, *Okoubaka aubrevillei*, *Scleropyrum*, and *Pilgerina madagascariensis*. Septate fibers were found in *Cervantesia tomentosa* (Fig. 6G) and observed by Butterfield et al. (1976) in some species of genus *Mida*.

Fiber-tracheids present in most of the species except *Pyrularia*, *Okoubaka aubrevillei*, *Scleropyrum*, and *Pilgerina madagascariensis*.

Vasicentric tracheids present in most of the species, except in *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Pyrularia*, and *Scleropyrum*. Vasicentric tracheids thin-walled, lumen wide and with distinctly bordered pits in *Myoschilos oblongum* and *Buckleya distichophylla*. The rest with vasicentric tracheids thick-walled, lumen narrow and small to medium bordered pits and included apertures.

DISCUSSION

Most species are characterized by the absence of growth rings but some species do have growth rings. Swamy (1949) observed growth rings in *Mida salicifolia* and *Santalum*, and Patel (1974) indicated absence in *Exocarpos bidwillii*, unlike what was observed in this study.

The diameter and density of vessels have consequences in conductive efficiency and safety (Carlquist 1977, 1988). Most species have vessel diameters that are very narrow to narrow. The narrowest vessels and highest number per mm^2 occur in *Leptomeria*, *Jodina rhombifolia*, *Thesium lineatum*, and *Myoschilos oblongum*. wider vessels and fewer number per mm^2 are present in *Scleropyrum*. *Santalum* and *Osyris*, with the greatest number of species distributed in diverse habitats, have vessels with tangential diameter between 30 to 60 µm, and a density of 23 to 80 vessels per mm^2.

The taxa with solitary vessels are *Santalum*, *Exocarpos*, *Osyris*, *Colpoon*, *Thesium lineatum*, *Leptomeria*, and *Scleropyrum*, and those with vessel groupings include *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Buckleya distichophylla*, *Pyrularia*, *Myoschilos oblongum*, and *Mida salicifolia* (Metcalfe 1935; Swamy 1949;

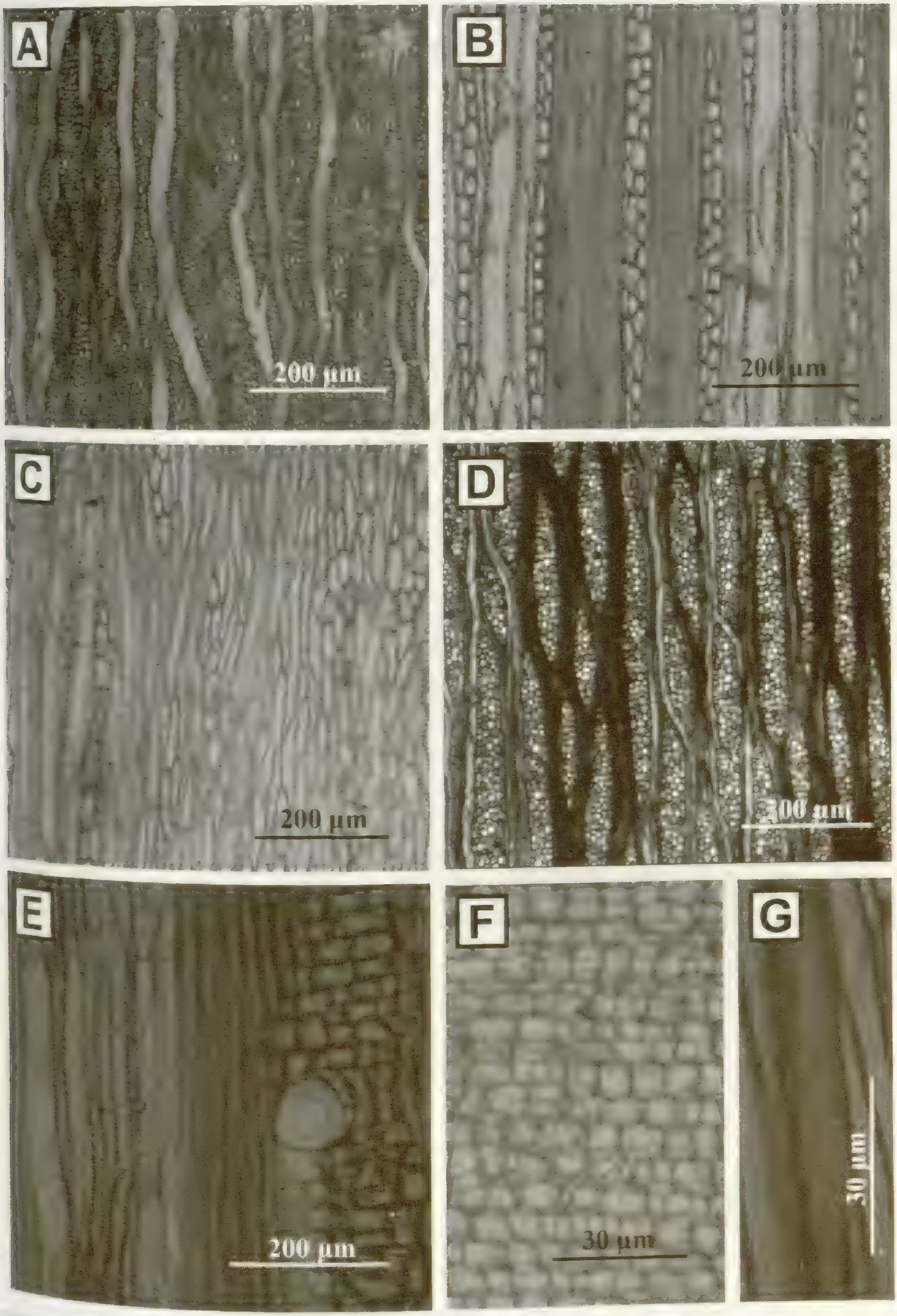

Fig. 6. LM micrographs of the wood structure in Santalaceae. **A,** *Acanthosyris spinescens*, larger rays commonly 4 to 10-seriate, TLS; **B,** *Pyrularia pubera*, rays 1–2 seriate, TLS; **C,** *Cervantesia tomentosa*, aggregate rays, TLS; **D,** *Jodina rhombifolia*, rays irregulary storied, TLS; **E,** *Pyrularia edulis*, perforated ray cell RLS; **F,** *Scleropyrum walichianum*, prismatic crystals in cells, RLS; **G,** *Cervantesia tomentosa*, fiber walls, TLS.

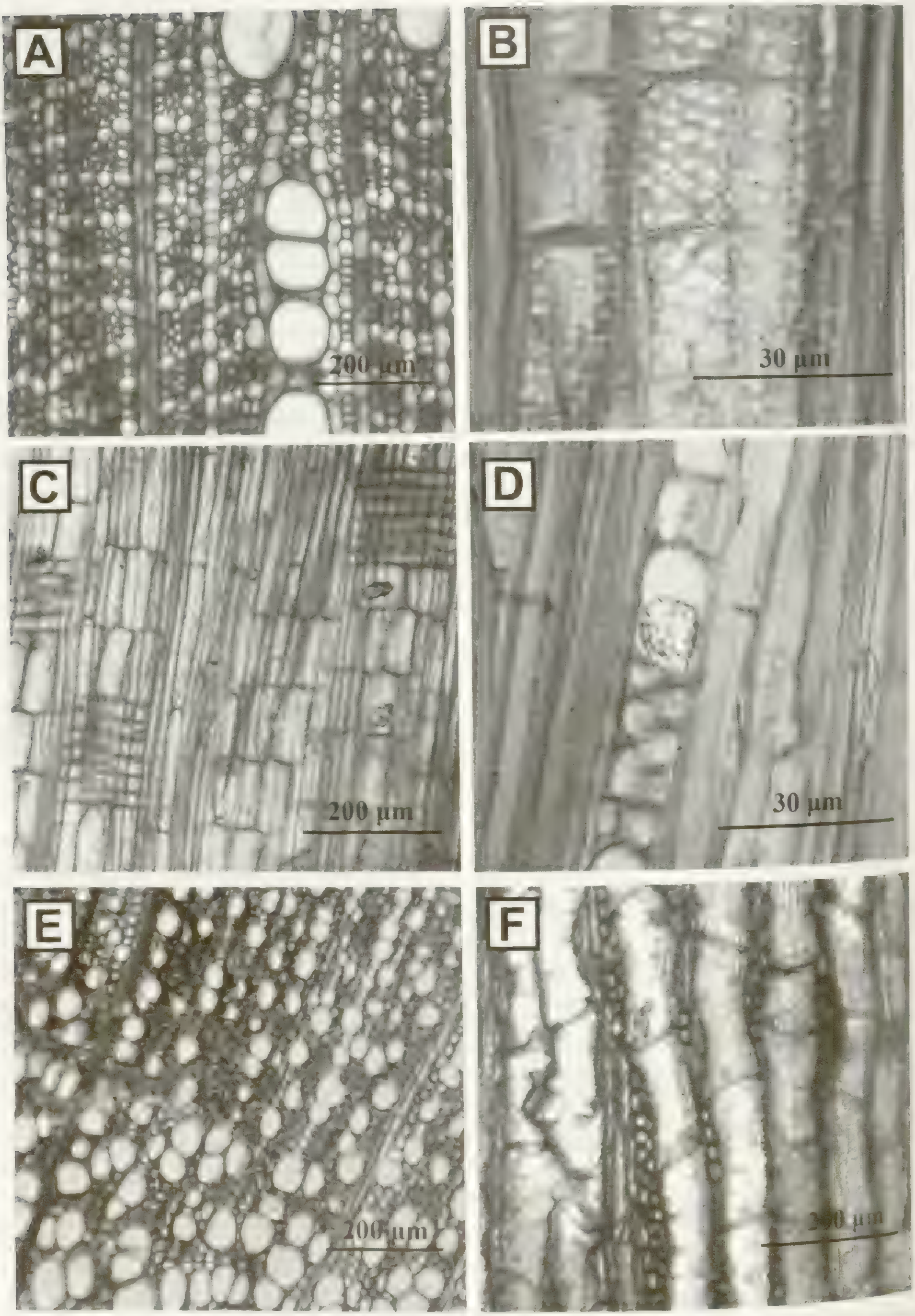

Fig. 7. LM micrographs of the wood structure in Santalaceae. A, *Okoubaka aubrevillei*, vessels in radial multiples, axial parenchyma diffuse-in-aggregates in fine lines, TS; B, *Okoubaka aubrevillei*, Vessel-ray pits with reduced borders to apparently simple, pit outline rounded, (RLS); C, *Okoubaka aubrevillei*, rays with procumbent body ray cells and over 4 rows of upright marginal cells, RLS; D, *Okoubaka aubrevillei*, druse in radial parenchyma cells, TLS; E, *Buckleya distichophylla*, semi-ring porous, TS; F, *Buckleya distichophylla*, Absence of axial parenchyma, TLS.

Metcalfe & Chalk 1950). The presence of vessel groupings and lack of solitary vessels is a xeromorphic character (Chalk et al. 1937; Baas et al. 1983; Carlquist 1966, 1977, 1980, 1984; Webber 1936). Carlquist (1966) describes some families with a vessel groupings increase with increasing aridity.

Perforation plates are simple in all species and in *Mida salicifolia* there are also scalariform plates (Patel 1974). The species with solitary vessels, except *Scleropyrum*, have more oblique perforation plates.

Tails on vessel elements may be present and/or absent depending on the species. Swamy (1949) showed absence of tails for *Exocarpos*, but they were observed by Patel (1974) and in the present study.

Helical thickenings in vessel elements were observed in *Acanthosyris glabrata*, *A. spiniscens*, *Cervantesia tomentosa*, and *Jodina rhombifolia* (Record & Hess 1943), *Pyrularia* (Swamy 1949), *Dendrotrophe varians*, *Exocarpos bidwillii* (Patel 1974), *Myoschilos oblongum*, *Osyris alba*, *O. quadripartita*, *Santalum album*, *S. insulare*, *S. austrocaledonicum*, *S. haleakalae*, *Santalum spicatum*, and *Mida salicifolia*. Helical thickenings in vessel elements are typical of species that develop in dry and cold temperate regions (Carlquist 1988).

Patel (1974) identified helical thickenings in vessel element tails of *Exocarpos bidwillii* and unusual thickenings that surround the pits and extend laterally. Metcalfe and Chalk (1950) mention striations due to the coalescent pits in Santalaceae. In the present study unusual thickenings around pits were observed for the first time in *Santalum album* and *S. insulare* (Fig. 4F).

The families generally have diffuse apotracheal axial parenchyma, which Kribs (1937) considered to be a primitive feature. *Acanthosyris glabrata*, *Osyris alba*, *O. lanceolata*, and *O. wightiana* have confluent axial parenchyma. *Scleropyrum walichianum* and *Eubrachion ambiguun* have fusiform parenchyma cells.

The species in relation to the fibers might be considered primitive, because the specialization indicating that fiber-tracheids are the most common primitive character; a few species have libriform fibers (Metcalfe & Chalk 1950, 1983; Vliet et al. 1981).

There is a correlation between the occurrence of exclusively solitary vessels and vasicentric tracheids (Carlquist 1984). Only *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Okoubaka aubrevillei* (Normand 1944), and *Pyrularia* lack vasicentric tracheids, and they have vessel groups.

CONCLUSIONS

Based on the characters of vessels, vasicentric tracheids, fibers, and the axial and ray parenchyma, the studied species are divided in two groups:

GROUP A: Present vessel groupings with few solitary, vessel outline circular; vessels in dendritic pattern (only *Jodina rhombifolia*, *Pyrularia*, *Myoschilos oblongum*, and *Mida salicifolia*); long fibers with simple to bordered pits, vasicentric tracheids (except in *Acanthosyris*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Pyrularia*, and *Scleropyrum*), fiber-tracheids (except in *Pyrularia*, *Okoubaka aubrevillei*, *Scleropyrum*, and *Pilgerina madagascariensis*), with uniseriate and multiseriate rays (width 3 to 6 cells) Heterogeneous (Kribs Type II) with one or more square marginal cells and/or upright to Homogeneous (Kribs Type I).

Species in Group A: *Acanthosyris falcata*, *A. spinescens*, *A. glabrata*, *Buckleya distichophylla*, *Cervantesia tomentosa*, *Jodina rhombifolia*, *Myoschilos oblongum*, *Okoubaka aubrevillei*, *Pyrularia edulis*, *P. pubera*, and *Pilgernia madagascariensis*.

GROUP B: This group consists of a large number of species with solitary vessel, outline angular, oval, and circular; vasicentric tracheids very thick-walled, elongated and with bordered pits; fiber-tracheids with bordered pits and coalescent apertures; uniseriate and multiseriate rays (2 to 4 cells wide), Heterogeneous (Kribs Type II) to Homogeneous (Kribs Type I).

Species in Group B: *Colpoon compressum*, *Dendromyza reinwardtiana*, *Dendrotrophe varians*, *Eubrachion ambiguum*, *Exocarpos bidwillii*, *E. brachystachys*, *E. cupressiformis*, *E. vitensis*, *Leptomeria billardieri*, *L. spinosa*, *Mida salicifolia*, *Osyris abyssinica*, *O. alba*, *O. lanceolata*, *O. quadripartita*, *O. tenuifolia*, *O. wightiana*, *Santalum album*, *S. austrocaledonicum*, *S. cuneatum*, *S. ellipticum* *S. fernandezianum*, *S. freycinetianum*, *S. freycinetianum* var. *pyrularium*, *S. freycinetianum* var. *lanaiense*, *S. haleakalae*, *S. hendersonense*, *S. insulare* var. *raiateense*, *S. insulare* var. *marchionense* *S. lanceolatum*, *S. paniculatum*, *S. yasi*, *S. spicatum*, *Scleropyrum walichianum*, *S. main-*

gayi, and *Thesium lineatum*.

The wood anatomy of Group A species shows more xeromorphic characters than the species of Group B. Most species of Group A belong to Cervantesiaceae (Nickrent et al. 2010) based on the new classification except for species of *Scleropyrum* that according to their anatomical characters, belong to Group B. These differences were also observed by Swamy (1949) and Metcalfe and Chalk (1950). *Okoubaka* has affinity with *Pyrularia* and *Scleropyrum* based on habit, fruit, and wood anatomy (Stauffer 1957). In the present study, *Okoubaka aubrevillei* has affinity with *Pyrularia*, *Acanthosyris*, and *Jodina*.

Myoschilos oblongum is part of Group A but the wood anatomy characters are completely different from the rest of the species of Santalaceae (Group B) according to the new classification (Nickrent et al. 2010). *Myoschilos oblongum* is adapted to cold regions where there is no water in the winter season.

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BOOK REVIEW

Roy L. Lehman, Ruth O'Brien, and Tammy White. 2009. **Plants of the Texas Coastal Bend.** (ISBN 978-1-60344-130-9, pbk.). Texas A&M University Press, John H. Lindsey Bldg., Lewis Street, 4354 TAMU, College Station, Texas, 77843-4354, U.S.A. (**Orders:** www.tamupress.com; 800-826-8911). $29.95, 368 pp., includes CD-ROM, 65 line drawings, 1 b/w photo, 6" × 9".

This second printing of *Plants of the Texas Coastal Bend* by Lehman et al. expands and updates the classic text *Flora of the Texas Coastal Bend* (1975) by Fred B. Jones. The "Texas Coastal Bend" includes all or parts of twelve Texas counties, including Aransas, Bee, Brooks, Goliad, Jim Wells, Kenedy, Kleberg, Live Oak, Nueces, Refugio, San Patricio and Victoria. The text includes nearly 70 individual drawings and comes with a compact disc with more than 750 color photographs. In all, about 1,150 species and varieties are included. The book is limited to trees, shrubs, vines, and wildflowers, but does not cover grasses as they have been well treated in other books.

The book is broken down into three main parts: an introduction (how to use keys, limits of the region, geology, climate, history of vegetation), the keys to the families, and species descriptions. These main parts are followed by an appendix that provides a list of color photographs on the companion CD, a glossary, bibliography, and index. The book is organized by botanical class and then alphabetically by family, genus and species. The plants are characterized by appearance, size, habit, occurrence, soil preference, flowering period, and for non-native species, place of origin. The scientific nomenclature follows Jones, Wipff, and Montgomery's (1997) *Vascular Plants of Texas*. Common names are provided, as well as extra information on rare and threatened plants. The keys were designed to be simple enough for amateur naturalists or botany students to correctly identify plants in the region.

To say that this book comes with a "companion" CD would be a bit of an understatement. Practically speaking, the reader will likely be using the CD images and the text keys' simultaneously when identifying plants. The CD's plant images are excellent and quite helpful for narrowing down plant identification. The CD that came with this review copy did contain a few errors. For some images, the file extension is not complete and the image will not display. Luckily, there is an easy fix. For example, opening up the folder for Asteraceae, you will see many images and a few blank ones. For the blank images, they have a file name, such as "Cirsium texanum flower white***.jp.***" Change to "Cirsium texanum flower white***.jpeg***" and the image will appear.

Overall, this is a solid resource for those botanizing the Texas coastal bend. The book is predominantly made up of the keys and species descriptions, thus it is not a practical field guide, but more helpful in the herbarium. If you work in the Gulf Coast of Texas, this book will be indispensable for making accurate and scientific plant identifications, whether you are a trained botanist, an amateur naturalist, or layperson.—*Kevin Janni, SWCA Environmental Consultants, 3901 Arlington Highlands Blvd, Suite 200, Arlington, TX 76018, kjanni@swca.com* and *Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

LIMITATIONS TO NATURAL PRODUCTION OF *LOPHOPHORA WILLIAMSII* (CACTACEAE) I. REGROWTH AND SURVIVORSHIP TWO YEARS POST HARVEST IN A SOUTH TEXAS POPULATION

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ABSTRACT

Lophophora williamsii (peyote) is a cactus whose crowns are commercially harvested for religious use as an ingested psychoactive sacrament by members of the Native American Church. Over the past quarter century peyote has become progressively less available, due in part to improper harvesting techniques and excessive harvesting. Since anatomical aspects of the regrowth of peyote and best harvesting practices were explicated in a previous study (Terry & Mauseth 2006), the principal focus in the present study was to determine the effects of harvesting where only best practices were employed. We assessed the effects of (1) harvesting per se (a single harvesting event evaluated after two years), (2) repeated harvesting (two harvesting events two years apart), and (3) not harvesting at all. After two years, the once-harvested group had a 90% survival rate and the unharvested control group had a 98% survival rate, a difference that was not statistically significant. The above-ground volume of the unharvested plants was significantly larger than that of the regrown harvested plants. While the regrown harvested plants had on average more crowns, their crowns were significantly smaller, in comparison to those of the unharvested plants. After two years, the surviving plants in the harvested group were divided into two subgroups, one of which was harvested for a second time. The other subgroup consisted of plants that had been harvested only once (at the start of the study) and were not reharvested. The weights of the crowns obtained in the second harvest were significantly lower than the weights of the crowns obtained in the first harvest from the same plants two years earlier. The net effect of a single harvesting was a reduction of plant above-ground volume by almost 80% after two years of regrowth. These data reflect what is occurring on a massive scale in habitat where peyote is commercially harvested. The annual numbers of crowns being harvested have not yet decreased drastically, due to the increased number of crowns produced as regrowth in response to harvesting. But the average size of the crowns in the regulated peyote market has decreased markedly due to too-early harvesting of immature regrowth crowns. These results—with emphasis on the conspicuous reduction in mean size of individuals—are typical of overharvested populations of wild-collected species, such as ginseng. The conclusion for conservation management is that reducing the frequency of harvesting of wild peyote would allow regrowth crowns to mature in size—thus reducing the number of crowns per dose required for sacramental consumption. It would also allow regrowth crowns to mature sexually, which would effectively de-suppress the production of seed for the next generation.

RESUMEN

Lophophora williamsii (peyote) es una cactácea, cuyos tallos se cosechan comercialmente para uso religioso como un sacramento psicoactivo ingerido por miembros de la Native American Church. En el último cuarto de siglo, el peyote se ha hecho progresivamente menos disponible, debido por una parte al uso de técnicas inapropiadas de cosecha y por otra a la práctica de cosechar en exceso. Ya que los aspectos anatómicos del recrecimiento del peyote y las mejores prácticas de cosecharlo fueron explicados en un estudio previo (Terry y Mauseth 2006), el enfoque principal en el estudio presente era determinar los efectos de cosechar utilizando solamente las mejores prácticas. Evaluamos los efectos de (1) cosechar de por sí (un solo evento de cosechar evaluado después de dos años), (2) cosechar repetidamente (dos eventos de cosechar, el segundo dos años después del primero), y (3) no cosechar. Después de los dos años, el grupo cosechado una sola vez mostró una tasa de supervivencia de un 90% y el grupo no cosechado mostró una tasa de supervivencia de un 98%, tal diferencia no fue estadísticamente significativa. El tamaño de la porción por encima del suelo de las plantas del grupo control fue significativamente mayor que el de las plantas que volvieron a crecer después de la cosecha. Mientras que las plantas cosechadas y vueltas a crecer tuvieron más coronas en el promedio, sus coronas fueron más pequeñas que las del grupo no cosechado—ambas diferencias fueron también significativas.

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Después de los dos años, las plantas supervivientes en el grupo cosechado fueron divididas en dos subgrupos, uno de los cuales fue cosechado por segunda vez. El otro subgrupo consistía de plantas que habían sido cosechadas una sola vez (al principio del estudio) y que no fueron recosechadas. Los pesos de las coronas obtenidas en la segunda cosecha fueron significativamente menores que los pesos de las coronas obtenidas en la primera cosecha de las mismas plantas dos años antes. El efecto neto de un solo evento de cosechar fue una reducción de casi el 80% del volumen de la porción de las plantas por encima del suelo. Estos datos reflejan lo que está ocurriendo a escala masiva en el hábitat donde el peyote se está cosechando comercialmente. Los números anuales de coronas de peyote que se están cosechando todavía no han disminuido, debido al número creciente de coronas producidas como consecuencia de cosechar. Pero el tamaño promedio de las coronas en el mercado reglamentado del peyote sí ha disminuido notablemente debido al cosechar demasiado temprano las coronas inmaduras de recrecimiento. Estos resultados—con énfasis en la reducción conspicua del tamaño promedio de los individuos—son típicos de poblaciones sobrecosechadas de especies recolectadas de la naturaleza, como por ejemplo el ginseng. La conclusión para la gestión de la conservación es reducir la frecuencia de cosechar el peyote silvestre permitiría que las coronas de recrecimiento maduren con respecto al tamaño—reduciendo así el número de coronas por dosis requerido para el consumo sacramental. También permitiría que las coronas de recrecimiento maduren sexualmente, lo que eliminaría efectivamente la supresión de la producción de semillas para la próxima generación

INTRODUCTION

Lophophora williamsii (Lem. ex Salm-Dyck) J.M. Coult. (Cactaceae), commonly known as peyote, is a small, spineless, globular cactus native to the Tamaulipan Thornscrub and Chihuahuan Desert of northeastern Mexico and areas close to the Rio Grande in South Texas and Trans-Pecos Texas (Figs. 1a, 2). A literature consisting of hundreds of published works on peyote goes back to early writings shortly after the Spanish conquest of Mexico (e.g., Hernández 1628). The human use of peyote for medicinal (Schultes 1938) and/or religious purposes (Stewart 1987) dates back to at least 6,000 years ago in the Lower Pecos region of the Chihuahuan Desert (Terry et al. 2006). Cultural, botanical, pharmacological, chemical, legal and taxonomic aspects of peyote and its conservation status up to the mid-1990s are summarized by Anderson (1996).

Peyote contains more than 50 alkaloids (Anderson 1996), which impart a bitter taste to the cactus (TH, pers. obs.). That flavor, plus the fact that some of the alkaloids cause physiological effects that could be interpreted as aversive, appear to deter most herbivores from eating the crowns (photosynthetic aerial tops of stems, aka "buttons") of peyote, with the notable exceptions of snails (Fig. 1b) and humans. Of the major alkaloids in *L. williamsii*, the predominant psychoactive compound is a phenethylamine called mescaline, whose effects on human perceptual function were described by Huxley (1954). In the all-night ceremonies of the Native American Church, peyote is ingested by the participants as a psychoactive sacrament, in the form of fresh cactus, dried buttons, or tea. The pharmacological action of the peyote in the central nervous system, potentiated by the auditory stimulation produced by traditional peyote songs accompanied by a water drum and a gourd rattle shaken at a particular frequency, induces a spiritually receptive state which led the Comanche chief Quanah Parker to observe (Simmons 1968): "The white man goes into his church house and talks *about* Jesus, but the Indian goes into his tipi and talks *to* Jesus."

Reports of decline and decimation of natural populations of peyote have intensified over the past two decades (Anderson 1995, 1996; Trout 1999; Terry & Mauseth 2006; Powell et al. 2008; Terry 2008a,b,c). But no national or international government or conservation organization currently lists *L. williamsii* as endangered or even vulnerable – except for the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), which lists all species of the Cactaceae in Appendix II, which "includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival" (CITES 1973). It may be argued that *L. williamsii* has a relatively large binational geographic range, and that there exist many healthy populations wherein the species is "common" (W.A. Fitz Maurice, in litt. 2011). However, those who have spent long periods of time in the field observing the well known populations—e.g., those populations reported and collected by Anderson (1960, 1969)—recognize that many of those populations are showing increasing signs of deterioration (decreased size and numbers of individuals, and decreased land area where *L. williamsii* can be found at all), and that the harvesting pressure on these populations appears to be increasing (MT, KT, BW, TH, pers. obs.). It is of interest that the far-sighted Mexican federal regulation NOM-059-SEMARNAT-2010 places *L. williamsii* in the conservation category which denotes that this is a species "subject to special protection" (SEMARNAT 2010). This position of the

FIG. 1a. *Lophophora williamsii* (peyote) in habitat at the study site near the Bordas Escarpment in South Texas. Visible are nine crowns (each crown is the photosynthetic apical portion of a stem or stem branch); one is very small at bottom right. When a crown is removed by cutting it off at ground level with a sharp instrument such as a machete, it becomes a "button" in the commercial peyote trade. Note the dense tangle of woolly trichomes concealing the apical meristems at the center of the largest crowns. The areole on each tubercle of a mature crown bears a tuft of trichomes. The tubercles are arranged in radial rows, and each such row of tubercles marks the midline of a rib. The two largest crowns shown have 13 ribs each. The middle-sized crown at bottom center has eight ribs. The small crown at top center has five ribs. The largest crowns shown are ca. 6–7 cm in diameter.

Mexican government is particularly significant because over 80% of the land comprising the geographic range of *L. williamsii* is Mexican territory. The most recent and relevant deliberations of the International Union for the Conservation of Nature (IUCN) on updating the conservation status of cacti of the Chihuahuan Desert have not been finalized as of this writing (B. Goettsch, in litt. 2011).

While much of the damage to peyote at the population level has been logically—but anecdotally—attributed to improper harvesting techniques and/or excessively frequent harvesting (TH, pers. obs.), there are no published studies to confirm or refute such claims or to characterize and quantify the effects of harvesting on subsequent production of harvestable peyote in its natural habitat. There is, however, considerable interest in the conservation of peyote among cactus conservationists, including many members of the Native American Church (NAC), whose members use peyote for legally protected religious purposes (TH, pers. obs.). Since anatomical aspects of the regrowth of peyote and best harvesting practices were explicated in a previous study (Terry & Mauseth 2006), the present study focused on the effects of harvesting per se (using best practices) on the survival and regrowth of this species *in situ* in South Texas.

MATERIALS AND METHODS

The study site was located in Jim Hogg County, Texas, within the area designated by Morgan and Stewart (1984) as "commercial peyote range" that extends westward to the Rio Grande from a geologic feature known as the Bordas Escarpment, which runs from Rio Grande City (on the Mexican border in Starr County) north to

Fig. 1b. A solitary peyote cactus near Rio Grande City in Starr County, Texas. Note the damage to the crown inflicted by herbivorous snails. The peyote crown is slightly less than 4 cm in diameter and has eight ribs (the rib on the right is eroded by snail feeding).

an area about 40 miles east of Laredo, Texas. The vegetation of the study site was typical of the Tamaulipan thornscrub that covers much of South Texas and adjacent northern Tamaulipas, Mexico. The study site was chosen because it showed only minimal signs of previous harvesting, and because it was isolated by distance from paved roads, which fact provided some reduction of the risk that the study would be compromised by the activities of peyote poachers.

One hundred peyote plants located along a belt line transect through the population were individually numbered and tagged. Fifty of the individuals were harvested by cutting off the crown at ground level with a carpet knife at the beginning of the study and the other 50 individuals were left unharvested at that time as controls. After two years, the surviving plants in the harvested group (a total of 42 of the original 50 plants) were divided into two subgroups. One of these subgroups (n = 20 plants) was harvested for a second time. The other subgroup (n = 22) was not harvested a second time.

Data on the survivorship of plants and on crown characteristics were collected annually for two years. Crowns are the photosynthetic aerial portions of the cactus stems, which, once cut off from the rest of the plant with a sharp instrument, are referred to as "buttons" in the peyote trade. Crown number and morphology were quantified by counting the number of crowns per plant and the number of ribs per crown, measuring the diameter of each crown, and weighing the harvested crowns in the fresh (not desiccated) state.

From these data, we calculated the total biomass harvested from each plant on each harvest date. For each plant we counted the number of ribs on each crown, summed the rib numbers across all crowns on the plant and divided the total by the number of crowns on the plant to obtain the mean number of ribs per crown for

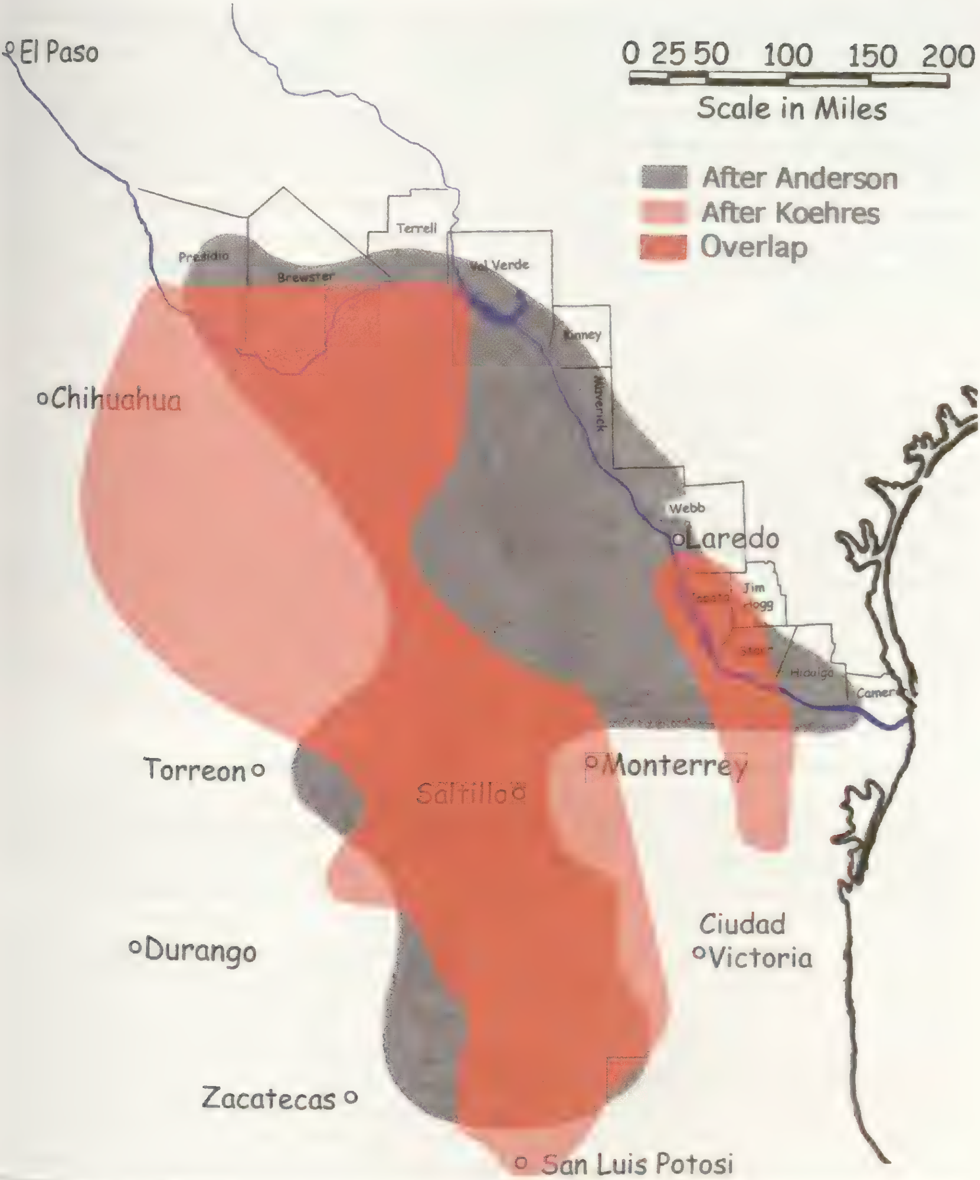

FIG. 2. Geographic distribution of *Lophophora williamsii* (peyote). Note that this is primarily a Mexican species, with over 80% of the land area in its geographic range in Mexican territory. Curiously, in Texas (the only U.S. state where the peyote occurs naturally) the plant is restricted to a narrow strip of land that to a large extent follows the Rio Grande.

that plant. We estimated the volume of each crown as a hemisphere with a radius equal to one-half its measured diameter. (In the case of asymmetrical crowns, whose diameter differed according to the orientation from which the measurement was taken, we measured minimum and maximum diameters [determined by inspection] and took the mean of the two measurements as the "diameter" of the crown in question.) Summing the estimated volumes of all crowns on a given plant gave us an estimate of the above-ground volume of the

plant at each time point in the study. This estimate of above-ground plant volume was linearly related to harvested fresh weight in the first harvest (Fig. 3). Total above-ground volume (hereafter, volume) per plant had the skewed distribution typical of plant sizes (a few large plants, many small plants) and was log-transformed before analysis; this transformation was sufficient to yield normal residuals in an ANOVA. Differences in mass between harvests were normally distributed without transformation. Kruskal-Wallis non-parametric tests were used to analyze the number of crowns per plant and several measures of within-plant morphology: crown diameter, crown volume, ribs/crown, and ribs/volume. Because so few plants died, survival was tested with Fisher's exact test. Of the 90 surviving plants, one was missing data on rib number and therefore does not appear in analyses involving rib number. All statistical analyses were done with SAS 9.1 (SAS Institute, Cary, NC, USA).

RESULTS

Survival.—A higher proportion of control plants than harvested plants survived, but the difference was not significant (97.92% of control plants versus 89.58% of harvested plants; Fisher's exact test, $P = 0.20$).

Plant size.—Two years after harvesting, the unharvested plants had significantly larger total volumes, on average, than the harvested plants did (ANOVA, $N = 90$, $F = 58.31$, $P < 0.0001$; back-transformed means were 22.75 cm^3 and 4.01 cm^3, respectively) (Fig. 4).

This difference in plant size affected the yield of the second harvest. The summed fresh weight of all crowns on a plant in the second harvest was, for 19 out of the 20 re-harvested plants, less than the fresh weight of the originally-harvested single crown of that plant. The average difference in plant mass between the two harvests was 13.98 g (std. dev. = 9.29), which is significantly different from zero ($N = 20$, $t = 6.73$, $P < 0.0001$). Although larger plants had higher yields in both harvests ($r = 0.82$, $P < 0.0001$, $N = 20$), initial plant size did not reduce the negative effects of the initial harvest on the yield of the second harvest: the larger the initial size, the larger the difference in mass between the two harvests (Fig. 5).

Measured fresh weights of crowns obtained in the two harvests were closely related to estimated volumes of the same crowns (first harvest: r_s(volume, mass) = 0.89, $P < 0.0001$; second harvest: $r_s = 0.95$, $P < 0.0001$; $N = 20$; volume was not normally distributed so Spearman non-parametric correlation coefficients are reported here). As one would therefore expect, the change in volume between harvests was strongly correlated with initial volume ($r_s = 0.96$, $P < 0.0001$) and somewhat less strongly correlated with the change in mass ($r_s = 0.67$, $P = 0.0016$).

Plant morphology.—Harvesting altered plant morphology (Table 1; Fig. 6). The initial harvest significantly increased the number of crowns per plant, from a median of one to a median of two per plant (Kruskal-Wallis test, $\chi^2 = 22.29$, df = 1, $P < 0.0001$). However, the crowns on these harvested plants were significantly smaller, with fewer ribs (Kruskal-Wallis test of estimated volumes, $\chi^2 = 56.13$, df = 1, $P < 0.0001$; Kruskal-Wallis test of ribs/crown, $\chi^2 = 37.71$, df = 1, $P < 0.0001$).

Effect of feral hogs.—An unanticipated phenomenon, which added complexity and uncertainty to our interpretation of some of the missing specimens on the transect, was the activity of feral hogs at the study site. Whenever we found a missing peyote specimen, it was necessary to make a determination of the cause of the disappearance of the tagged plant and to classify the presumed death of the plant as harvest-related or non-harvest-related. In some cases we could locate neither the peyote plant nor its tag nor even the metal stake to which the tag had been wired. The use of an appropriate metal detector (Minelab X-Terra 305) eventually resulted in the location of all of the lost plants that had merely been covered by soil washed down the slope by heavy rains. But where there was clear evidence of feral hog rooting, some missing plants were never found. Feral hogs are a non-native species in the region; they began to increase rapidly in population in the area of the study site in the early 1990's (C.W. Hellen, pers. comm.). Accordingly, we decided to exclude from the study those plants which we determined to be missing as a result of feral hog activity. Fortunately there were only two hog-implicated missing plants excluded from the harvested group of 50 plants, and an equal number of such plants were excluded from the control group. It should be noted that if we had counted these missing

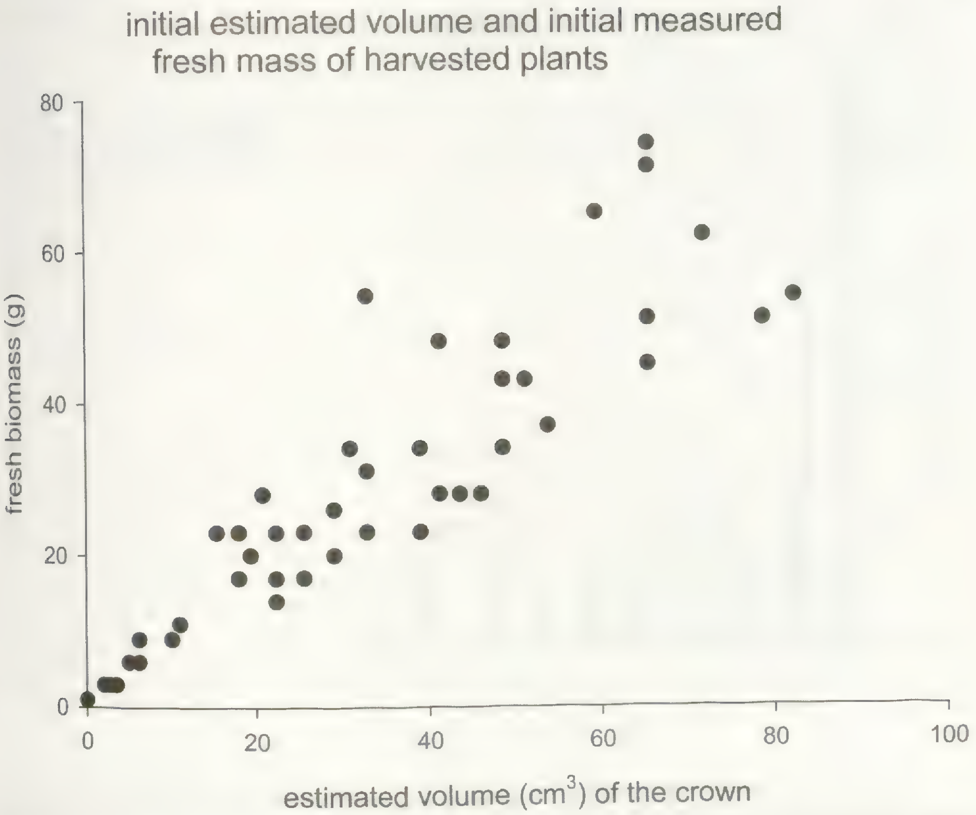

Fig. 3. Initial estimated volume and initial measured fresh weight of crowns harvested at beginning of study. Volume of each crown was estimated as a hemisphere with radius equal to half the measured diameter of the crown. Estimated volume and fresh weight are closely related (Spearman non-parametric correlation coefficient $r_s = 0.91$). This fact is useful because there were no detached crowns to be weighed in the control group of unharvested plants, which meant that the only way to compare the sizes of harvested crowns and those of unharvested crowns was by their volumes, based on diameter measurements.

plants as harvest-related deaths instead of excluding them from the study, that interpretation would have tripled the mortality in the control group from ca. 2% to 6% and increased the mortality in the harvested group from ca. 10% to 14%.

DISCUSSION

The observed increase in the number of crowns (i.e., buttons) per plant that resulted from the initial harvest is compatible with the common belief that "…harvesting [is] conducive for Peyote growth, and…harvesting also increases the number of new plants" (Morgan 1976). Harvesting may not affect survival, as the observed arithmetic reduction in survival was not significant. However, harvesting clearly reduced crown size so much that the negative effect of harvesting on crown size outweighed the increase in crown number also caused by harvesting. A parallel decrease in the fresh weight of the crowns of plants that were reharvested after two years, was also observed. This empirical result of harvesting—somewhat larger numbers of substantially smaller peyote buttons—suggests that our experimental protocol adequately modeled the system of commercial harvesting that generates the peyote buttons being offered for sale by licensed peyote distributors in South Texas, which has resulted in mostly very small, immature buttons being offered for sale (as seen in Fig. 7).

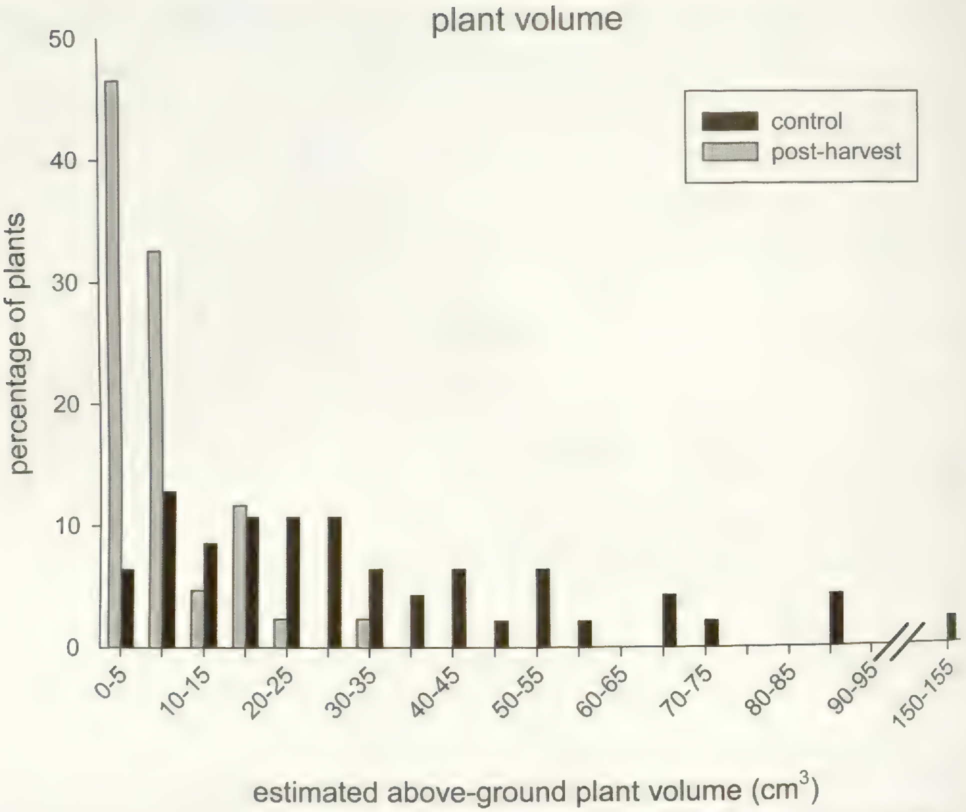

Fig. 4. Distribution of above-ground plant volumes (summed crown volumes for each plant, estimated as in Fig. 1), two years after initial harvest. Note the high frequencies of the smallest plant size categories in the harvested group (gray bars), and the moderate to low frequencies of a wide range of different sizes of plants in the control group (black bars). The largest sizes of plants in the control group were not observed at all in the harvested group. The harvested group had many more small plants than did the control group. This comparison of plant volume frequency distributions is one way of portraying the marked reduction in above-ground plant size that results from harvesting.

Annual peyote sales data covering the last quarter century are presented in Figure 8. One curve, showing the total annual sales of peyote in dollars, has an overall positive slope that is characteristic of many commodities that are subject to ordinary price inflation. The other curve showing total number of buttons sold annually—which we interpret to be a close approximation of the number of buttons harvested annually—indicates that the annual number of buttons harvested is considerably more stochastic, with a substantial downturn from 1986 to 1989, followed by a remarkable rebound from 1990 to the peak of about 2.3 million buttons sold in 1997, and from that point forward, a roughly continuous decrease from 1997 to 2010. Considering only the recent interval from 1997 to 2010, however, the picture is simpler: The positively sloped curve showing total sales in dollars intersects the negatively sloped curve showing numbers of buttons sold (harvested). That is to say, prices have gone up as numbers of buttons sold have gone down, which is rational market behavior when a commodity becomes progressively less available.

The data in Fig. 8 include only the regulated sales by the licensed peyote distributors to documented members of the NAC for legally protected religious use. What percentage of the total market this regulated segment comprises, is an open question. There is minimal hard evidence of smuggling of peyote from Mexico into the U.S. (Gee 1998), but there is clear and abundant evidence that Mexican peyote populations are being

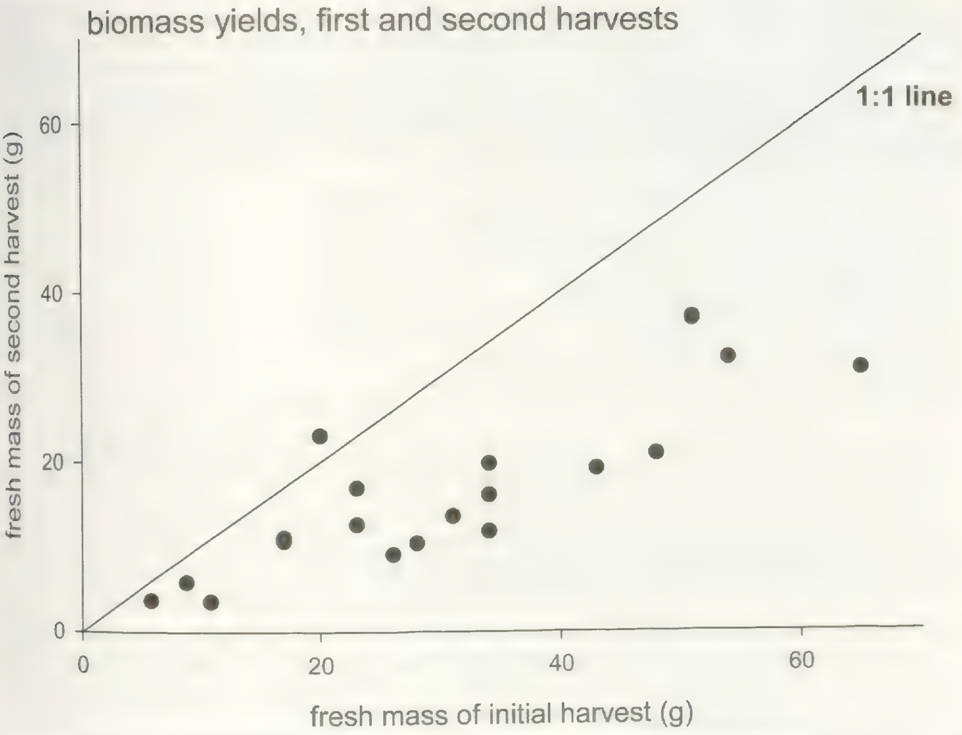

FIG.5. Biomass yields of first and second harvests from the same individual plants. Fresh weights of harvested crowns of plants that were harvested at the beginning of the study, with the exception of a single data point, were consistently and significantly higher than the fresh weights of regrowth crowns obtained when the same plants were reharvested (i.e., all regrowth crowns were removed) two years later. Such decreasing yield associated with harvesting is a hallmark of an unsustainable system of production.

pillaged by poachers who dig up the entire plants in massive quantities for some unidentified market that requires specifically *L. williamsii* and not the other, non-mescaline-containing species of *Lophophora* that occur in Mexico (Terry 2008a,b,c). No one knows how much peyote is harvested annually by Native Americans who make private agreements with landowners who have peyote growing naturally on their land. And no one knows how much peyote is harvested illegally by poachers who supply the Native American Church or other consumers. We could estimate the annual consumption of peyote buttons in the U.S. by making some assumptions about the number of NAC members in the U.S., the number of peyote meetings attended per NAC member per year, and the average number of peyote buttons consumed per person per meeting. But apparently no one even knows how many members of the NAC there are, due to the fact that the NAC is not a single entity, but rather a totally decentralized set of independent NAC organizations, most of which communicate with each other only sporadically, if at all. The Native American Church of North America (NACNA) is an umbrella organization that represents a relatively small number of relatively large tribal church groups, but it almost certainly represents only a minority of the total membership of all NAC groups in the U.S. Such factual deficiencies notwithstanding, for the sake of a hypothetical calculation let us use an estimate of Anderson (1996) that the total NAC membership is about 250,000. If we divide the current annual regulated sales number of ca. 1.5 million buttons by 250,000 members, we get an average of six peyote buttons per person per year. That might be enough peyote for each member to attend one peyote ceremony per year, if we were talking about full-size mature peyote buttons. But in fact we are talking about small regrowth buttons that constitute most of the offerings in the current regulated peyote market, which means that six buttons per person would not even

TABLE 1. Average values of selected variables two years after the initial harvest. Standard deviations in parentheses. Study began with 50 plants being harvested and 50 left as unharvested control plants. Plant volume is the sum of the volumes of all the crowns on a given plant; i.e., it is the total volume of above-ground photosynthetic stem tissue, which is identical to the total volume of harvestable "button" tissue that constitutes the commercial product in the peyote trade. No of crowns/plant was determined by counting. Crown diameter was measured with a ruler scored in mm. Crown volume was calculated as half the volume of a hemisphere having the radius equal to half the measured diameter. Volume so calculated for the crowns of peyote in this study was strongly correlated with weight (Fig. 3). No. of ribs/crown was obtained by counting. (See Figs. 1a, 1b for depiction of ribs and examples of rib numbers.)

Variable	Control plants	Harvested plants
Plant volume[1]	32.46 cm^3 (28.48)	6.94 cm^3 (6.66)
No. of crowns/plant	1.70 (1.56)	2.60 (1.13)
Crown diameter[2]	40.10 mm (11.96)	19.39 mm (6.04)
Crown volume[2]	22.17 cm^3 (16.67)	2.77 cm^3 (2.46)
No. of ribs/crown[2]	9.30 (2.35)	6.79 (0.77)

[1]Estimated from crown diameter for each crown separately, then summed.
[2]These are means of means: averaged across all crowns on a plant, then averaged across all plants.

suffice for an adequate dose of sacrament for every member to participate in one ceremony per year. We know that one meeting per year is nowhere near the cultural norm for the frequency of meetings in the NAC. Some churches may hold meetings almost weekly—say, 50 meetings per year (Bobby Pedro, pers. comm.). If all NAC groups held meetings at such a frequency, then more than 50 times the amount of peyote sold in the regulated system would be required to meet the needs of the NAC for sacrament. Even with a lower frequency of meetings and assuming that not all NAC members attend meetings every year, the daunting magnitude of the disparity between the amount of peyote sold and accounted for in the regulated peyote trade and the amount likely to be required by the NAC seriously erodes the credibility of the proposition that most of the peyote supplied to the NAC comes through regulated channels.

Why have the annual numbers of buttons sold not decreased more drastically and consistently to reflect the damage being done to the wild peyote populations? And why does the market price of peyote appear not to have risen more sharply as well? The high frequency of harvesting, modeled by a two-year interval between harvests in the present study, together with the related decrease in the size of regrowth buttons, provides plausible answers to those questions. Our results suggest that the numbers of buttons sold annually have not decreased as dramatically as one might expect because the harvesting of solitary mature crowns increases the number of buttons in a population by stimulating lateral branching from areoles on the subterranean portion of the stem of a decapitated plant, which often results in the regrowth of multiple, but much smaller, crowns per plant.

The effect of harvesting on price to the consumer (as opposed to total gross sales revenue to the vendors) is more dramatic than the data of Fig. 8 suggest, because Fig. 8 does not take into account declining button size. A few decades ago the harvesting frequency of peyote was lower, and the buttons being harvested for sale to the NAC were principally mature crowns similar to the larger plants in the present study (Mauro Morales, pers. comm.). Now, however, the harvesting frequency has generally increased and mature plants are relatively scarce (Morales, pers. comm.), with the result that the market is dominated by small regrowth crowns similar to those in the harvested group in the present study. In terms of weight, whereas commercial peyote a few decades ago would have typically consisted of buttons weighing on the order of 25–30 g each on average (Morales, pers. comm.), now the average weight of a button, like the average weight of the individual second-harvest crowns in the twice-harvested group in this study (5.8 g), is likely to be in the single-digit range in grams. The price increased from $78/1000 buttons to $310/1000 buttons from 1986 to 2010, a fourfold nominal increase, but only twofold after adjusting for inflation (Bureau of Labor Statistics http://www.bls.gov/data/inflation_calculator.htm). If, however, buttons were only one-fifth as large in 2010, the price per gram was actually ten times higher in 2010 than in 1986. Increasing unit prices, like declining harvests (Fig. 6) and declining individual size (Fig. 2), are a common consequence of unsustainably high rates of harvest (Allen et al. 2005).

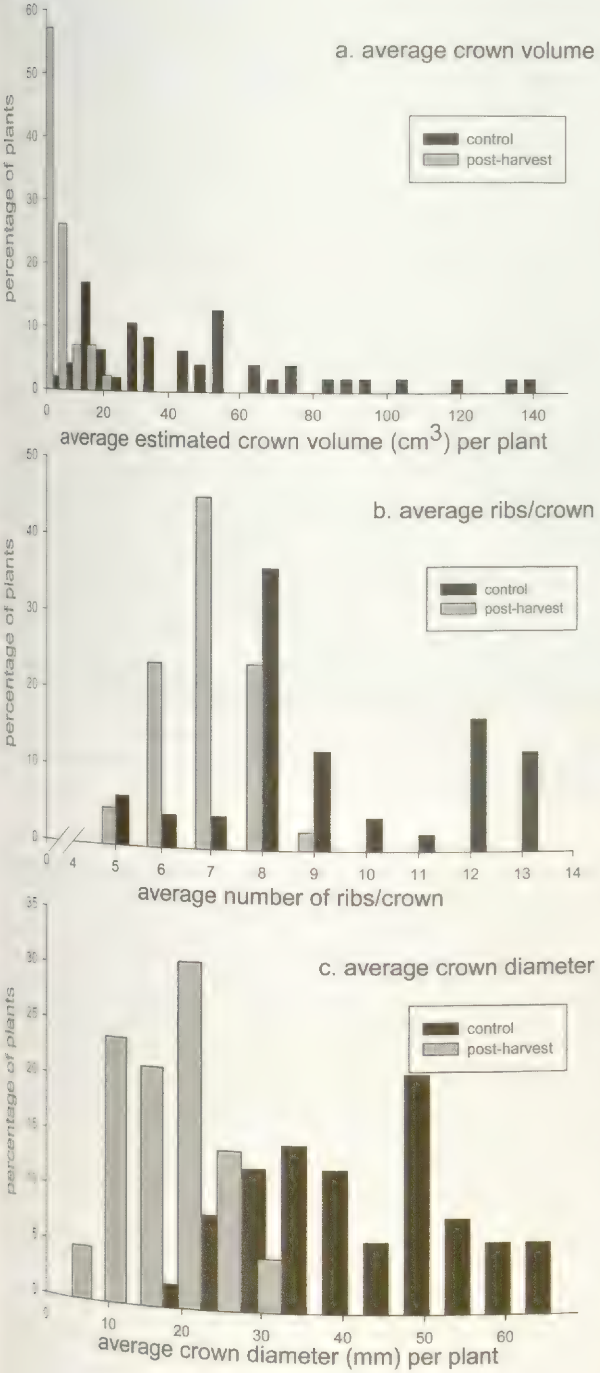

Fig. 6a. Distribution of average crown volume per plant. The average crown volume was calculated for each plant. Average crown volume for a given plant is the summed crown volume of Fig. 4 divided by the number of crowns on the plant. For the many control plants that had only one crown, average crown volume is equal to average plant volume of Fig 4. For harvested plants, which often had more than one crown, average crown volume is a fraction of average plant volume. For those harvested plants that showed no regrowth, the average crown volume is zero. Note that the majority of harvested plants show average crown volumes in the smallest size bin (≤ 5 cm^3), and ca. 85% of the harvested plants show average crown volumes in the two smallest size bins (≤ 10 cm^3). In contrast, the control plants have average crown volumes in 20 different size bins across the entire range of average crown volumes from 0 to 140 cm^3. This is another way of portraying the reduction in average crown size associated with harvesting.

Fig. 6b. Distribution of average number of ribs per crown, per plant. For plants with only one crown, this is equivalent to the number of ribs per plant. Otherwise, it represents an average of all crowns on a plant. Rib number is roughly correlated with size and age of the crown. Note the modal values of 8 ribs for control plants and 7 ribs for harvested plants. Eight is the Fibonacci number of ribs characteristic of a crown of a young adult plant; most control plants in this study had only one crown, of 8 ribs. The modal value of 7 ribs/crown in harvested plants reflects the presence of immature as well as mature crowns on these plants. The Fibonacci number 13 is the maximum rib number observed for the control plants, as it is for the species. The minimum rib number observed in both harvested and control plants is the Fibonacci number 5, as is likewise true of the species.

Fig. 6c. Distribution of average crown diameter per plant. Crown diameters are not as dramatically different between control and harvested plants as are estimated volumes (Fig. 4), because volume is a function of the cube of the radius (i.e., the cube of half the diameter). Nevertheless, note the relatively small area of overlap in the values of this variable for harvested vs. control plants. This is yet another way of depicting that the regrowth crowns of harvested plants are generally smaller than the crowns of nonharvested control plants.

FIG. 7. Small peyote buttons in a drying bin at a licensed peyote distributor's place of business in South Texas. Most of the buttons shown are less than 4 cm in diameter, and many are less than half that size (Photo by Kurt Böhme).

It is tempting to carry the argument one step farther and hypothesize that the concentration of mescaline (the predominant and most potent psychoactive alkaloid in peyote) in the regrowth buttons is likely to be considerably lower than that in the crowns of mature plants not previously harvested. That notion is compatible with anecdotal complaints by NAC members about the "sweet" taste (suggesting low levels of the alkaloids that normally impart a bitter taste to peyote) and low psychoactive efficacy of the small buttons currently being sold in the trade (TH, pers. obs.). If true, such a deficiency in mescaline concentration associated with the immaturity of the small regrowth buttons would be adding an additional hidden component to the real per-gram price of peyote associated with excessively frequent harvesting, as a greater quantity of tissue from immature crowns would be required to provide the same dose of mescaline as would be obtained from the "normal" (smaller) quantity of tissue from mature plants. The analytical chemistry work comparing the mescaline concentrations of mature first-growth crowns and immature regrowth crowns is currently in progress (Terry et al., in preparation), but the data are not yet available.

Another notable result was the significant decrease in the biomass (measured as fresh weight) of the second harvest, compared to the biomass yielded from the same individual plants in the initial harvest two years previously at the start of the study. It is reasonable to infer from this decreased second-harvest yield that the time interval of two years between harvests is too short to be sustainable. Yet judging from the size of the peyote buttons currently being offered for sale in the trade, two years appears to be a commonly accepted period of time to allow regrowth prior to the next harvest (MT, pers. obs.). Similar decreases in individual size have occurred in other wild-harvested species, where they often indicate unsustainable levels of harvesting (e.g., Hall

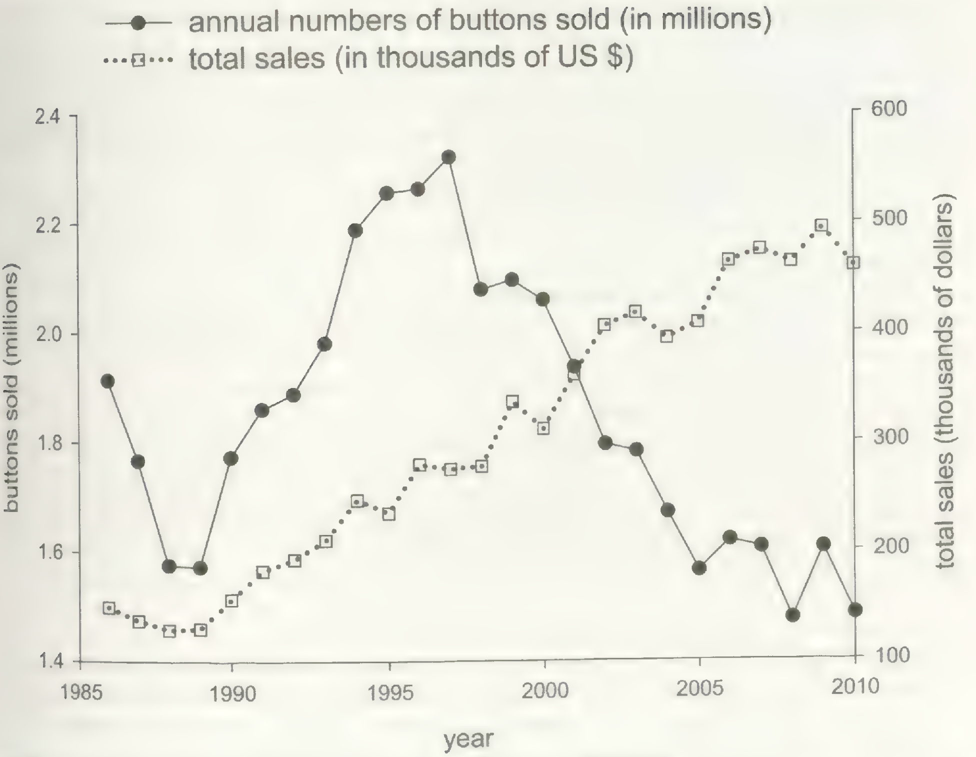

FIG. 8. Annual sales of peyote by licensed distributors, 1986–2010. Solid curve: numbers of buttons sold (in millions—see vertical axis at left). Dotted curve: total sales (in thousands of dollars—see vertical axis at right) paid for the annual crop by NAC members. The marked decrease in the average size of buttons that has occurred over recent decades is not shown and is not inferable directly from these data. Drawn from data obtained from Texas Department of Public Safety in 2011.

and Bawa 1993; Nantel et al. 1996; McGraw 2001; Berkeley et al. 2004; Case et al., 2007; Genner et al. 2010). The literature on overharvesting of ginseng (*Panax quinquefolia*) is particularly relevant to our findings on peyote. Genner et al. (2010) determined from herbarium specimen collection data that there has been a long-term decrease in the overall population size (number of individuals counted in a systematic census) of ginseng as a species in specific regions of its geographic range. Case et al. (2007) showed from herbarium specimen data that the size of individual ginseng plants collected has decreased over a period of decades. Nantel et al. (1996) used mathematical modeling and population data to show that both harvesting frequency and harvesting intensity (defined as the percentage of individuals harvested from a population each time the population is harvested) are key factors in reducing the population growth rate of ginseng. For example, given a harvesting frequency of once every five years, harvesting 30% of the individuals in a population at each harvesting event would be sufficient to reduce the population growth rate below the equilibrium value of 1.0, where the death rate due to harvesting is exactly equal to the reproductive replacement rate of individuals. When the growth rate falls below the equilibrium value, population size decreases, and a decrease in population size is the ultimate criterion for unsustainable harvesting. The decrease may be postponed and temporarily masked in the case of peyote by an initial post-harvest proliferation of small regrowth crowns that elevate the census despite the reduction in total population biomass. Another reliable indicator of unsustainable harvest is a decrease in the average size of harvested individuals, as found by Case et al. (2007) with ginseng and in the present study with peyote. It should be noted that, in terms of the Nantel et al. (1996) model, the harvesting intensity in the

harvested group of peyote plants in the present study was 100%; i.e., all plants in that group were harvested. This fact, and the fact that regrowth of the harvested commodity occurs in peyote, constitute important differences between peyote and ginseng. With wild ginseng, harvesting intensities may be lower than for peyote, but every ginseng plant that is harvested is a plant removed from the population—that is, a death, insofar as the population is concerned. That is not true of peyote, which has the ability to produce regrowth from the subterranean stem, if the latter survives the harvesting process.

One additional observation from our experience suggests that for long-duration plant studies conducted *in situ* in South Texas, it may be worth considering building a sturdy exclosure fence around the study site before starting the study, to exclude feral hogs.

Conclusions as to optimizing the management of natural peyote production must be considered preliminary at this point, as this report covers only the first two years following a controlled harvesting event in a peyote population that had minimal signs of previous harvesting. It is quite conceivable that delayed differences in survivorship attributable to the initial harvest may be discernible by the four-year time point in this ongoing study. At that time there will also be survivorship data associated with the second harvest, as well as data on the biomass yield from a third harvest for comparison with the first two harvests reported here. What we can state now with confidence, based on the data presented here, is that (1) a two-year interval between peyote harvests is too short to be sustainable, and that, (2) in light of the reduced total biomass yield of the second harvest compared to the first, the economically adverse effect of harvesting on button size outweighs the beneficial effect of harvesting on number of buttons per plant.

ACKNOWLEDGMENTS

We are appreciative of the interest and cooperation of C.W. Hellen Ranches, Ltd. – La Mota Division – Charles W. (Bill) Hellen, Managing Partner, who graciously allowed us to conduct this study on their ranch in the heart of the South Texas peyote habitat. We also thank Brandon Baca, Sam Baca and Tammy Terry, for getting down on the same level with the peyote plants, under the low thorny canopy of the acacias, and doing the hard work of locating the plants, measuring their diameters and counting their ribs. We greatly value the comments of two reviewers, Domitila Martinez Alvarado and an anonymous reviewer. Essential funding for the study was kindly provided by Elizabeth Winston-Mize, the Alvin A. and Roberta T. Klein Foundation, and an anonymous donor.

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BOOK REVIEW

STANLEY A. RICE. 2011. **Life of Earth: Portrait of a Beautiful, Middle-Aged, Stressed-Out World.** 2011. (ISBN 978-1-61614-225-4, hbk.). Prometheus Books, 59 John Glenn Drive, Amherst, New York 14228-2197, U.S.A. (**Orders:** http://www.prometheusbooks.com/). $28.00, 255 pp., photos, 6" x 9".

While we are all certainly familiar with the old adage, "You can't judge a book by its cover," it is a genuine delight to report that this one not only has a beautiful cover, it is a genuine "page-turner" from start to finish. Biologist Rice has provided us with an unexpectedly unique and inclusive, well-balanced coverage.

A glance at the Table of Contents certainly peaks the reader's interest. After *List of Illustrations* and *Introduction: A Pile of Rocks in the Middle of Kansas*, the reader encounters Chapter 1. Meet Mother Earth; Ch. 2. Inevitable Evolution; Ch. 3. Innovation; Ch. 4. Symbiosis; Ch. 5. Sex; Ch. 6. Altruism; Ch. 7. Religion; Ch. 8. Science; and Ch. 9. Faith in Photosynthesis. How could anyone possibly not be fascinated by that line-up?

This volume is not simply a recitation of various biological episodes in the history of our planet. (We are approximately half-way through Earth's estimated ten-billion-year "life span.") Obviously human occupation throughout the ages has had a tremendous impact on Gaia, the name the ancient Greeks had bestowed upon planet Earth, and retained here. Rice has provided a very thorough analysis of the impact—both positive and negative—that mankind has had since its presence and interaction. And, he has done so with skill, humor, and an obvious love and concern for the planet. He does not mince words when it comes to extreme human religiosity among populations that impact the care and protection of Gaia. (Interestingly, he tells of his dismissal from a church-sponsored university for being "too liberal." He still considers himself "somewhat conservative.")

Rice writes with ease, obvious knowledge and love of Gaia and its life-cycles, as well as our home planet—and with a great sense of humor. It is fun, entertaining, enlightening—and encouraging!—to read.—*Helen Jeude, Assistant Editor, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

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CLINAL GEOGRAPHIC VARIATION IN MESCALINE CONCENTRATION AMONG TEXAS POPULATIONS OF *LOPHOPHORA WILLIAMSII* (CACTACEAE)

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ABSTRACT

A phytochemical analytical study was conducted to address the question of whether *Lophophora williamsii* (peyote) plants from Chihuahuan Desert populations in the Trans-Pecos region of West Texas exhibited higher tissue concentrations of mescaline than plants from Tamaulipan Thornscrub populations of South Texas. This question is of cultural significance to the Native American peyote religion, which involves the ingestion of peyote as a psychopharmacologically active sacrament. Tissue samples were field-collected from 10 individuals in each of four *L. williamsii* populations, two of which were located in the Chihuahuan Desert, and two of which were located in the Tamaulipan Thornscrub ecoregion. For each of the four populations, the tissue samples from 10 individual plants were pooled, the alkaloids were extracted, and the average mescaline concentration of the population was determined by HPLC. There was limited geographic variation in mescaline concentration; the highest concentration (3.52% of dry tissue) was only 27% greater than the lowest (2.77%), and the difference between the Chihuahuan Desert populations and the Tamaulipan Thornscrub populations was not significant. However, mescaline concentrations increased significantly along a gradient from southeast to northwest, i.e., from the southeasternmost Tamaulipan Thornscrub population to the northwesternmost Chihuahuan Desert population.

RESUMEN

Se hizo un estudio fitoquímico analítico para contestar esta pregunta: ¿Tienen las plantas de *Lophophora williamsii* (peyote) en las poblaciones del desierto chihuahuense en la región Trans-Pecos de Tejas concentraciones de mescalina en los tejidos más altas que las concentraciones en las plantas de poblaciones en la ecorregión matorral espinoso tamaulipeco del sur de Tejas? Esta pregunta tiene importancia cultural para la religión del peyote de los nativos americanos, la cual implica la ingestión del peyote como un sacramento psicofarmacológicamente activo. Muestras de tejido de 10 individuos por población fueron recogidas en el campo de cuatro poblaciones de *L. williamsii*, dos de las cuales estaban localizadas en el desierto chihuahuense, y dos en el matorral espinoso tamaulipeco. Para cada una de las cuatro poblaciones, las muestras de tejido de 10 plantas individuales fueron juntadas y mezcladas, los alcaloides fueron extraídos, y la concentración promedia de mescalina fue determinada por HPLC. Hubo variación limitada en la concentración de mescalina. La concentracion más alta (3.52% del peso de tejido seco) fue solamente un 27% más alta que la más baja (2.77%), y la diferencia entre las poblaciones del desierto chihuahuense y las del matorral espinoso tamaulipeco no fue significativa. Sin embargo, las concentraciones de mescalina se incrementaron significativamente a lo largo de un gradiente desde el sureste hacia el noroeste, es decir, desde la población más al sureste en el matorral espinoso tamaulipeco hacia la población más al noroeste en el desierto chihuahuense.

INTRODUCTION

Lophophora williamsii (Lem. ex Salm-Dyck) J.M. Coult. (Cactaceae) is a small (up to ca. 8 cm in diameter), spineless, globular cactus of northeastern Mexico and adjacent Texas (Figs. 1a, 1b). Commonly known as peyote, it is of cultural and economic importance for its use as a religious sacrament, based largely on the psy-

FIG. 1a. An adult peyote cactus (diameter ca. 6 cm) in habitat in Chihuahuan Desert.

FIG. 1b. Six small peyote cacti (diameter of largest individual is ca. 4 cm) in habitat in Tamaulipan Thornscrub. The circular grouping and small size indicate that these plants are regrowth resulting from the harvesting of the crown of the parent plant (not visible) by peyote cutters in recent years.

choactive properties of its principal alkaloid, mescaline, in the ceremonies of the Native American Church (NAC). Peyote is also used therapeutically by many Native American tribes as a medicinal plant for the treatment of a wide variety of conditions (Schultes 1938), though it is unclear whether therapeutic efficacy is related to the activity of mescaline in such uses of peyote. Regulated sales of wild-harvested peyote by licensed distributors in the U.S.A. total ca. 1.5 million "buttons" (harvested tops of stems) per year (Texas Department of Public Safety, *in litt.* 2011).

One reason for analyzing the tissue mescaline concentrations in four geographically disjunct populations of peyote is based in ethnobotany. Thomas Blackstar, the most senior of the elders of the NAC in the Comanche tribe (which is centered in southern Oklahoma near Lawton), stated anecdotally that there is a preference among some Native Americans (notably the Kiowa) for the "purple peyote" of West Texas (Blackstar, pers. comm.). The name "purple peyote" refers to seasonally drought-stressed plants which appear to have resorbed and metabolized much of their chlorophyll, leaving the reddish betalain pigments as the dominant chromogenic compounds (Fig. 2).

A reasonable ethnobotanical interpretation of Blackstar's statement—and one that is considered valid by other NAC members in Oklahoma (Terry, pers. obs.)—is that the preference for peyote in this "purple" condition for ceremonial use is based on the perception that it is "stronger" (a word that suggests higher mescaline content) than ordinary, non-stressed, gray-green to blue-green peyote (as shown in Fig. 1). An illuminating fact is that this cultural preference for purple peyote is also a de facto geographical preference, since the purple peyote normally occurs only in the Chihuahuan Desert region of Trans-Pecos Texas and adjacent Mexico. The present study was accordingly designed to determine whether there were greater concentrations of mescaline in the Chihuahuan Desert populations of West Texas than in the Tamaulipan Thornscrub populations of South Texas (Fig. 3).

Another reason for doing this phytochemical analytical study of geographically disjunct populations of two ecologically different regions was the potential chemotaxonomic value of such a study. There has been discussion in the literature since the 1940's about possible taxonomic differences between the Chihuahuan Desert populations and the Tamaulipan Thornscrub populations of *Lophophora williamsii* (Croizat 1944; Weniger 1970; Bravo 1971; Powell and Weedin 2004). One quantitative character that has not previously been evaluated in this regard is tissue concentration of mescaline, which might reasonably be expected to vary from one ecoregion to another by virtue of variation of the status of regulatory genes affecting the rate of biosynthesis, which would be an example of the phenotypic plasticity described by Schlichting and Smith (2002). It could be of taxonomic value to determine whether the Chihuahuan Desert populations show inherently different (in either direction, higher or lower) tissue concentrations of mescaline than the Tamaulipan Thornscrub populations. Such a quantitative phytochemical difference—or lack thereof—would add to the evidence available for evaluating the validity of recognizing of a new variety of *L. williamsii*. The original chemotaxonomic hypothesis was that there is a significant difference in the tissue mescaline concentrations of plants sampled from the two geographic regions.

Alternatively, the mescaline concentrations may increase in a gradual fashion across the entire Texas portion of the range of this species. The four populations studied fell along a rough gradient from southeast to northwest: from Starr County (RES) north to Jim Hogg County (LMR) in the Tamaulipan Thornscrub ecozone, then northwest to Val Verde County (LTR) and west to Presidio County (STR) in the Chihuahuan Desert ecozone (Fig. 3). In terms of the gradient, the appropriate ethnobotanical hypothesis is that mescaline concentrations increase along this gradient, and the appropriate chemotaxonomic hypothesis is that they differ, in either direction, along the gradient.

MATERIALS AND METHODS

Samples of aerial stem tissue (ca. 4 g fresh weight from each individual) were field-collected by biopsy from 10 individuals in each of four Texas populations (designated RES, LMR, LTR and STR) of *Lophophora williamsii*: two in the Tamaulipan Thornscrub (RES in Starr County and LMR in Jim Hogg County) and two in the Chihuahuan Desert (LTR in Val Verde County and STR in Presidio County). (See map, Fig. 3.)

Fig. 2. "Purple peyote" in habitat in Chihuahuan Desert. Plant shows reddish betalain pigment and depleted chlorophyll resulting from the severe drought of 2010–2011.

In order to eliminate the possible confounding factors of drought stress and dehydration from this geographic phytochemical analysis, we collected all the peyote tissue samples during the rainy season in July 2010 and desiccated the tissue samples prior to analysis. There is an untested but prevalent belief among NAC members that older/larger peyote plants constitute "stronger medicine" than younger/smaller plants (Teodoso Herrera, pers. comm. based on his personal experience as spiritual leader of the Native American Church of the Rio Grande, and on the opinions of his numerous NAC colleagues). Accordingly, in order to eliminate the possible confounding factor of different stages of maturity of the plants sampled for this study, we collected tissue samples exclusively from individuals with eight ribs, which are young adult plants that are typically ca. 3–5 cm in diameter (Terry et al., unpublished data).

The samples of cactus tissue were cut into small slices, and the individual samples were pooled by population and set to dry for a week on a drying rack. Once desiccated, the tissue was ground to a fine powder with a mortar and pestle.

A sample of 2.0 g of the ground dry cactus tissue from each population was then Soxhlet-extracted with 200 ml HPLC-grade methanol for 8 h. The methanol extract was evaporated to dryness, and the residue of the extract was dissolved in 200 ml HPLC-grade water, which underwent acid-base extraction with dichloromethane, as described in Ogunbodede et al. (2010). The dichloromethane was evaporated to dryness, and the residue, containing the mescaline and related alkaloids, was redissolved in 10.0 ml of methanol and stored at −20°C in a labeled vial. The four extracts representing the four populations were run on an Agilent 1260 Infinity HPLC, using 9:1 water to acetonitrile acidified with 0.1% trifluoroacetic acid as the mobile phase, and a Phenomenex Gemini 5μ C18 column. Samples of 1.0 μL were injected with a flow rate of 1.2 ml/min and run for 30 min. Each of the four samples was run three times and the values of area under the curve (AUC) for the three peaks per sample were averaged. A standard curve of mescaline standard was generated and used to in-

Fig. 3. Map of sampled populations of peyote, showing geographic location and average mescaline concentration of each population. Note slight and irregular—but continuous—increase in mescaline concentration from one population to the next in geographic order from southeast to northwest.

terpolate the concentration of mescaline corresponding to the mean AUC of each sample. Then back calculations were done to determine the original concentration of mescaline (as percent, w/w) in the desiccated tissue samples from the four populations of peyote.

Confirmation of the identity of mescaline in these samples was achieved with GC-MS. A sample methanol extract of *L. williamsii* from this study was evaporated to dryness under an N_2 stream at room temperature, and the residue dissolved in dichloromethane for analysis. The instrumentation was an Agilent 6890 GC equipped with a DB-5ms (0.25 mm I.D. x 30 m) column, splitless injection (250°), and an Agilent 5972 MSD (transfer line at 275°), operated in full scan mode. Helium was used as the carrier, and the oven program was 70° (with a 1 min hold), then 20°/min to 250°, with a final hold.

RESULTS

On GC-MS, the mescaline peak had an identical retention time to an authentic reference sample, and the mass spectrum matched a spectrum in the NIST database (Stein et al. 2005) with 93.5% probability of best match.

The average mescaline concentration for each population sampled is presented along with the geographic

location of the population in Fig. 3. There was limited variation among the four samples, as the highest concentration of mescaline (3.52%, in STR) was only ca. 27% greater than the lowest concentration (2.77%, in RES). A t-test comparing Chihuahuan Desert and Tamaulipan Thornscrub populations was not significant ($P = 0.26$) —not surprising given the small number of populations sampled and the resulting low statistical power.

However, the order of increasing mescaline concentrations in the four populations sampled matched our suggested geographic gradient exactly. The lowest concentration was in the Starr County population (RES), at the southeastern end of the gradient, and the highest concentration was in the Presidio County population (STR), at the northwestern end of the gradient. Of the 24 possible permutations in which the four different mescaline concentrations of the four populations could be ordered, only two would match the gradient: one of them with the mescaline concentrations increasing from southeast to northwest, and the other one with the mescaline concentrations decreasing from southeast to northwest.

Under the gradient version of the chemotaxonomic hypothesis, we are asking whether there are consistent differences in mescaline concentrations along the gradient in either direction, and so a two-tailed statistical test is appropriate. The probability of obtaining one of the two permutations with the geographic order of populations the same as the order of the mescaline concentrations in either direction is 2 out of 24, or $P = 0.083$, not significant but suggestive of a possible geographical pattern (cline) in mescaline tissue concentration in this species.

Under the gradient version of the ethnobotanical hypothesis, we are asking specifically whether mescaline concentrations increase from southeast to northwest in Texas, and the appropriate statistical test is therefore one-tailed. Only one of the 24 permutations of the four populations produces a match between geographic order from southeast to northwest and order of increasing mescaline concentrations, and that is the permutation obtained in this study. That outcome has a probability of 1 out of 24, or $P = 0.042$. That is to say, the mescaline concentrations significantly increase in Texas along this southeast-to-northwest gradient.

DISCUSSION AND CONCLUSIONS

It is important to understand the pharmacological relationship between mescaline concentration in the plant and the dose of mescaline ingested by a person in a peyote religious ceremony. If peyote is available from two populations, A and B, and the peyote from A contains a mescaline concentration 25% higher than that of the peyote from B—all other things being equal—a given person can attain exactly the same dose by eating 100 g of A or 125 g of B. And in a peyote meeting where each participant titrates his/her own dose to attain the desired subjective spiritual effect, the difference between peyote from A and peyote from B would not be viewed as a matter of concern (Teodoso Herrera, pers. comm.). However, if the difference in mescaline concentration were considerably greater, such that a person would have to ingest a much larger quantity of the peyote from B to attain the same dose of mescaline as a person ingesting peyote from A—as might be the case where the peyote from B consisted of small, immature plants that would taste "sweet" due to their low alkaloid content—then the peyote from B would be deemed undesirable by many members of the peyote religious community, both because of the low levels of mescaline and because eating immature plants would deny the plants the opportunity to reproduce themselves (Herrera, pers. comm.). The range of mescaline concentrations seen in this study is more reflective of the former situation, where the difference between the high and low extremes is perceptible but not objectionable.

One factor that may have affected the average mescaline concentration in the RES population of Starr County is that we found considerable evidence of previous harvesting of the peyote in that population (e.g., groups of small regrowth plants as shown in Fig. 1b). Extensive photographic documentation of such post-harvest regrowth in this population can be seen in Terry and Mauseth (2006). If it were the case that peyote crowns that grow as lateral branches from the subterranean stems of harvested plants are, at least for several years, deficient both in size and in mescaline content—as is widely believed but only partially documented (Terry et al. 2011)—then it would be reasonable to expect that a population such as RES, in an area known for intensive commercial peyote harvesting, would show evidence of such harvesting in the form of depression of the average mescaline content of the population.

While we were not able, in this study, to differentiate statistically between the mescaline concentrations of Tamaulipan Thornscrub and Chihuahuan Desert peyote populations, our results suggest a likelihood that such a difference may exist. We were also able to demonstrate a significant geographical pattern consistent with somewhat higher concentrations in populations located in the more northern and western regions of the range of the species in Texas. These first results on how tissue levels of the principal peyote alkaloid vary with geography are compatible with the anecdotal Native American perception that peyote from Texas populations of the Chihuahuan Desert is more efficacious as a pharmacologically active religious sacrament than peyote from populations farther to the south and east in the Tamaulipan Thornscrub. Geographically more extensive fieldwork is in progress to obtain *L. williamsii* tissue samples from a larger number of populations, which will afford the statistical power required for more definitive resolution of the chemotaxonomic question.

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BOOK REVIEW

ALAN E. BESSETTE, WILLIAM C. ROODY, AND ARLEEN R. BESSETTE. 2010 (first edition paperback of an earlier hardback 2000 edition). **North American Boletes: A Color Guide to the Fleshy Pored Mushrooms.** ISBN 978 0-8156-3244-3, hbk., alk paper). Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, New York 13244-5290, U.S.A. (**Orders:** 800-365-8929, supress@syr.edu). $45.00, 400 pp., 2 b/w, 454 color illustrations, 8" × 10".

This book mirrors the beauty and morphological features of the bolete mushrooms with color images and descriptive narrative that will entice the more technical professional and casual user alike. There are approximately 300 species illustrated with color images and morphological descriptions using both macroscopic (heavily emphasized) and microscopic characteristics. New information highlighting macrochemical tests and color changes enhance the value of the species descriptions based on the bolete biota of North America north of Mexico. Species descriptions include pileus, pore surface, stipe, spore print color, fruiting (habit, seasonal occurrence, and geographic distribution), comments, and edibility. Under the heading of comments are miscellaneous notes dealing with synonymy, similar species, interesting facts, and field impressions.

A brief historical review is given that includes both past and present students of boletes beginning with Lewis David von Schweinitz, and then Walter H. Snell and Esther A. Dick, Alexander H. Smith, and more recently Ernst F. Both among others. The fleshy pore fungi are a varied group with highly prized edibles such as *Boletus edulis* and in addition many species that form an ectomycorrhizal symbiotic relationship sharing nutrients with the roots of trees as well as food for wildlife. The typical bolete fruiting body has a spore-bearing layer comprised of vertical tubes forming a thick, sponge-like fleshy area described in detail in the introductory sections. This information will prepare users to better understand species descriptions.

Boletes are some of the larger fleshy fungi found in nature so that they are frequently collected by amateurs but are often difficult to identify. Field keys are dichotomous, based on macroscopic characters and separated into species found in eastern and western regions with the dividing line the Rocky Mountains. The beginner will find the keys for the most part user friendly even though some bolete species have distribution patterns not fully known.

The color images were scanned from 35mm color slide form and arranged 3 ¼ x 2 ⅛ inches usually five or six per page. The high quality of the color images along with excellent close up composition showing cap. pore and stipe surfaces enable the collector to match characteristics in species descriptions with key characters used in identification. The paper is heavy 86 pound stock that is best for four-color separation and allows for minimal show-through from one side of the page to the other. The color images are grouped as a block in one section and not interleaved with the black and white species description pages. This book is oversized for use in the field, however, the spine is saddle-stitched at the binding edge in 16-page sections then perforated to receive glue that holds all of the pages into the paper cover. Rough handling should not result in splitting the spine and loose pages.

Review continued on page 688

REGISTRO DE UNA NUEVA LOCALIDAD DE *LOPHOPHORA WILLIAMSII* (CACTACEAE) A PUNTO DE EXTINCIÓN POR SAQUEO EN COAHUILA, MÉXICO

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RESUMEN

Las cactáceas son un recurso no renovable que está siendo saqueado de manera indiscriminada. En casos particulares como la cactácea *Lophophora williamsii* distribuida en el ejido Sauceda, las especies no son aprovechadas medicinalmente y mucho menos en ritos ancestrales de la cual es sujeto esta especie. Desgraciadamente la desaparición de poblaciones como esta y otras especies de interés (medicinal y ecológico), estan ocurriendo diariamente a causa de los cactófilos.

ABSTRACT

Cacti are a non-renewable resource that is being plundered indiscriminately. In particular cases, such as that of *Lophophora williamsii* which is distributed in the ejido Sauceda {ejido=land cooperatively owned}, the species are not being exploited for medicinal purposes nor for ancestral rites. Unfortunately the demise of populations like this and other species of medicinal and ecological interest are caused daily by cactus enthusiasts.

México es reconocido por la diversidad de plantas albergadas (Rzedowski 1978; Gómez-Pompa et al. 1994) como consecuencia de las condiciones fisiográficas, climáticas y edáficas (Villarreal y Encina 2005). Además, la Región del Desierto Chihuahuense le confiere elementos representativos únicos de la familia Cactaceae (Hernández y Bárcenas 1995). La mayor parte del estado de Coahuila está incluida en el Desierto Chihuahuense (Henrickson y Johnston 1997). En la región Coahuilense, se distribuyen 29 especies de cactáceas amenazadas (Hernández y Godinez 1994). *Lophophora williamsii* J.M. Coult. (IPNI 2011) es una especie de distribución no endémica (NOM-059-SEMARNAT 2010), sin embargo, se encuentra sujeta a protección especial y es un elemento importante de la flora cactológica del desierto Chihuahuense (Hernández y Godinez 1994; Hernández y Bárcenas 1995 y 1996; Gómez-Hinostrosa y Hernández 2000; Hernández et al. 2001). Esta especie se distribuye desde la cuenca del Río Bravo en la parte de Texas y México (Bravo-Hollis y Sánchez Mejorada 1991), extendiéndose hasta los estados de Chihuahua, Coahuila, Nuevo León, San Luis Potosí, Tamaulipas y Zacatecas (Guzmán et al. 2003; Henrickson y Johnston 1997; Britton y Rose 1963). La especie no había sido reportada anteriormente para el municipio de Sauceda, Coahuila. (Guzmán et al. 2003; Henrickson y Johnston 1997; Britton y Rose 1963) solo de manera general para el municipio de Ramos Arizpe, Coahuila. (Villarreal 2001). De acuerdo a las condiciones de precipitación anuales para Coahuila (< 600 mm) *L. williamsii* es una especie abundante (Jiménez 2011); sin embargo, la extracción desmesurada disminuyó considerablemente la población localizada al norte de Sauceda en el municipio de Ramos Arizpe, Coahuila México.

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Hallazgo de la población de *L. williamsii*

En agosto del 2006 realizando recorridos por la zona candelillera del ejido Sauceda (25°49'41.6"N y 101°17'49.6"W) municipio de Ramos Arizpe, se localizó una planta adulta de 20 cm de diámetro a nivel de suelo con 22 coronas. Posteriormente en septiembre del 2006, se regresó al área para realizar un censo de la especie, la cual se distribuye en matorral parvifolio de *Larrea tridentata* J.M. Coult., *Agave lechuguilla* Torr. y *Fouquieria splendens* Engelm. (IPNI 2011). La totalidad de las plantas fueron ubicadas a dosel de *A. lechuguilla* aún y cuando el elemento dominante y de mayor cobertura es *L. tridentata*. El tipo de suelo donde se distribuye la población corresponde a xerosol háplico (Anónimo 1995) poco pedregoso.

Primer censo de la población

En septiembre del 2006 se aplicó el primer muestreo estratificado (Franco 1985) para censar la población, la cual ocupaba un área de 1.2 Km^2. Se geoposicionaron 12 cuadros de 10 × 10 (Sánchez-Salas et al. 2010) donde se cuantificaron 165 ejemplares. La totalidad de los ejemplares presentaron en promedio tres rebrotes y el estado de los individuos se consideró como vigoroso. Las plantas pertenecían a diferentes edades debido a que presentaban entre cinco y ocho costillas (Schultes y Hofmann 1982).

Segundo censo del 2011

En marzo del 2011 se realizó nuevamente un recorrido por la zona y se cuantificaron los individuos en los mismos cuadrantes. Desafortunadamente como sucede con la mayoría de las cactáceas, y en particular con aquellas con efecto alucinógeno como el "Peyote" la población disminuyo drásticamente (Batis y Rojas 2002; Hernández-Ortiz 2008; Montero y García 2010). Se procedió a la aplicación del mismo proceso metodológico. De las 165 plantas cuantificadas para septiembre del 2006 se encontraron un total de 28 y solo 12 presentaron tres rebrotes (nuevas coronas ramificando del tallo subterráneo) en promedio. Esto significa que hasta 30 plantas en promedio se pierden al año por el saqueo desmesurado. Considerando lo determinado por Schultes y Hofmann (1982) podemos decir que aparentemente las plantas eran adultas pues saquearon las de mayor número de costillas, poniendo en riesgo su permanencia in situ.

Estado actual de la población

Lophophora williamsii está adaptada al microambiente semiárido y responde satisfactoriamente con altos niveles de sobrevivencia y regeneración, que se puede observar por la generación excesiva de rebrotes sobre las plantas adultas (Terry y Mauseth 2006). Este patrón de regeneración se observó por primera vez en septiembre del 2006, sin embargo, actualmente la producción de coronas disminuyó. Podemos suponer que la disminución se deba al sobre pastoreo y las prácticas agrícolas. Anderson (1996) considera que las poblaciones de esta especie utilizadas para corte ritual (corte de parte aérea del peyote) en un periodo de tres años se recuperan por completo debido a su alta capacidad resiliente. Considerando el tiempo transcurrido desde que se encontró por primera vez la población de *L. williamsii* (septiembre del 2006) a la fecha (hace cuatro años y medio) la población debería estar recuperada totalmente (Anderson 1996). No obstante, ésta va en declive, pues la planta no es usada para rituales ni con fines medicinales según pobladores del ejido Sauceda; simplemente los "Peyoteros" están sobre explotándola.

Fragmentación del ecosistema donde se distribuye *L. williamsii*

Lophophora williamsii muestra selectividad por plantas nodriza según el estado de conservación o degradación en que se encuentre el sitio. La especie muestra una asociación con *Larrea tridentata* cuando el ecosistema se encuentra en buen estado y con *Opuntia leptocaulis* cuando el nivel de perturbación es medio (Montero y García 2010). La totalidad de plantas de *Lophophora williamsii* se encontraron a dosel de *A. lechuguilla*, y ninguna asociada a las determinadas por Montero y García (2010).

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BOOK REVIEW (CONTINUED)

ALAN E. BESSETTE, WILLIAM C. ROODY, AND ARLEEN R. BESSETTE. 2010 (first edition paperback of an earlier hard-back 2000 edition). **North American Boletes: A Color Guide to the Fleshy Pored Mushrooms.** ISBN 978 0-8156-3244-3, hbk., alk paper). Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, New York 13244-5290, U.S.A. (**Orders:** 800-365-8929, supress@syr.edu). $45.00, 400 pp., 2 b/w, 454 color illustrations, 8" × 10".

(*Review continued from page 684*)

Six pages of terms found in the glossary and used mostly in conjunction with species descriptions help the reader to understand terminology usage. There are references of recommended reading and specific works cited that offer background sources of additional information on the bolete literature. I found features of the Indexes to be especially helpful in finding specific information such as the Index to Common Names along with the color illustrations denoted in italics. This helps to find a given color image since it is not conveniently placed next to the species descriptions. The Index to Genera and Species arranged alphabetically by genus and then species also is a quick way to find a given species.

There are many mushroom books available for purchase but this one should be at the top of the list for anyone interested in learning more about fungi in natural habitats. Individual members of the North American Mycological Society and the more than 80 clubs in Canada, Mexico, and the United States of America should have this book on their bookshelf. College, university, and public libraries will want to have this affordable book available to the general public to enjoy the biodiversity of fungi. State, national parks, and conservation agencies will also be interested in this book as a reference. There are few books that span the broad readership spectrum of amateur to professional mycologists as well as naturalists but this one touches all of the bases.
—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

DISTRIBUCIÓN Y DIVERSIDAD DE LA FAMILIA POACEAE EN CHIHUAHUA, DURANGO Y ZACATECAS, MÉXICO

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RESUMEN

Se analiza la distribución geográfica y diversidad de las gramíneas en tres estados del norte-centro de México (Chihuahua, Durango y Zacatecas), aplicando técnicas de análisis espacial con Sistemas de Información Geográfica. El objetivo principal fue mostrar la distribución y diversidad de la familia Poaceae en el área de estudio, para lo que se utilizaron registros de ejemplares de herbario. Con ayuda del programa Diva-GIS, se construyó una cuadrícula regular (de 0.5 × 0.5 grados) en el territorio que comprende los tres estados y se determinó el número ejemplares colectados y riqueza de especies, lo que permitió visualizar los efectos de la intensidad de colectas y se detectaron areas de escasa o nula exploración botánica. Se calculó la diversidad aplicando los índices de Shannon y de Margalef. Los resultados señalan que las áreas con mayor diversidad se ubican en las zonas templadas con vegetación de bosques y pastizales naturales, por otra parte se presenta menor diversidad en la zonas con vegetación xerófila, aunque se aprecia un sesgo que ha provocado una mayor diversidad en zonas cercanas a las ciudades capitales de los tres Estados, así como a lo largo de las principales carreteras pavimentadas. Se concluye que estas técnicas de análisis espacial permiten obtener información útil sobre la diversidad y para futuras colectas, a pesar del sesgo mostrado.

PALABRAS CLAVE: Distribución geográfica, diversidad, norte de México, Poaceae, SIG

ABSTRACT

We analyzed the geographic distribution and diversity of grasses in three states of north central Mexico (Chihuahua, Durango, and Zacatecas), using spatial analysis techniques with GIS. The main objective was to document the distribution and diversity of the family Poaceae in the study area. Data were extracted from specimens in major herbaria in Mexico and the United States. Using the Diva-GIS program, we built a grid (0.5 × 0.5 degrees) in the three states, counted the number of herbarium specimens, and determined species richness; we looked at the intensity of collections from different sites and compared them to areas with little or no collections. Diversity was calculated using the Shannon and Margalef index. The results indicate areas with greater diversity are located in temperate areas with forests and grasslands, and lower diversity was recorded in xerophytic regions. There is greater collecting in and around the capital cities of the three states, as well as along the main highways. In spite of the intensity of collecting near population centers and principal highways, we conclude that our analysis provides useful information in determining the location of grass diversity and where future collecting might be focused.

KEY WORDS: Diversity, geographic distribution, GIS, north central Mexico, Poaceae

INTRODUCCIÓN

El estudio de la diversidad biológica es fundamental para entender el funcionamiento de los ecosistemas, la necesidad de su conocimiento se incrementa constantemente para tener un sustento en el manejo y preservación del funcionamiento de los ecosistemas. Esto se logra a través de proyectos de medición de la biodiversidad que consisten en el muestreo, separación, catalogación, cuantificación y mapeo de sus entidades, tales como los genes, individuos, poblaciones, especies, hábitats, ecosistemas y paisajes. Así, la síntesis de la información resultante permite analizar los procesos que la determinan. La correcta evaluación de la biodiversidad provee información esencial para el manejo de los ecosistemas, ya sea para conservación o restauración Moreno 2001a).

Raven et al. (2011) mencionan que el éxito de las prácticas de conservación se fundamenta en buenos estudios taxonómicos, en el conocimiento ecológico, distribución geográfica y el entendimiento evolutivo de la biodiversidad. Cada uno de estos importantes aspectos en el proceso de estudio de la biodiversidad, representan tareas científicas independientes que sin embargo se conectan fuertemente.

Las especies de la familia Poaceae como cualquier ser vivo tiene una distribución que obedece a cierto

orden, ya que las plantas no están distribuidas al azar, sino que algunos factores limitan su distribución. La mayoría de los vegetales son inmóviles, lo que quiere decir que deben satisfacer sus requerimientos "*in situ*": allí donde viven deben obtener las materias primas para su sustento, además de tener las condiciones físico-químicas adecuadas. Las especies requieren diferentes condiciones para su óptimo desarrollo (Ederra 1997).

La familia Poaceae, quizás la de mayor importancia económica para la humanidad, presenta unos patrones de distribución y diversidad que obedecen a disponibilidad de sus requerimientos de materias primas y a las condiciones físicas del ambiente en que se desarrollan. Dicha distribución y diversidad son las propiedades que se analizarán en el presente estudio.

Con la idea de abordar algunos de los aspectos que conlleva el estudio de la biodiversidad de plantas, en este caso de las gramíneas distribuidas en el norte-centro de México, se han llevado a cabo revisiones taxonómico-florísticas de la familia Poaceae, en los estados de Chihuahua, Durango y Zacatecas (al norte-centro de México) en el herbario CIIDIR del Instituto Politécnico Nacional (Herrera 2001; Herrera y Cortés 2010; Herrera et al. 2010). En ellos se registran más de 100 géneros y cerca de 500 especies de gramíneas que se distribuyen de forma natural en esta región. Donde se analizarán datos de solo presencia de especies, tomados directamente de ejemplares de herbario (alrededor de 8000) revisados con fines taxonómicos.

MATERIALES Y MÉTODOS

Datos digitales

Los datos digitales georreferidos utilizados en este trabajo fueron tomados de la base de datos BIOTICA generada en revisiones de gramíneas en los tres estados incluidos. Se convirtieron las coordenadas geográficas a grados decimales y se exportó como un archivo de texto (separado por tabulaciones), este archivo se importó en el programa de aplicación de SIG y se generó una cubierta (mapa digital) de puntos de sitios de colecta en formato shape para iniciar el proceso y análisis de su distribución. Mediante aplicaciones de tecnología de Sistemas de Información Geográfica (SIG), en este caso el paquete DIVA-GIS, que fue desarrollado para análisis de diversidad y distribución de especies con el objeto de dilucidar patrones geográficos, ecológicos y genéticos (Hijmans et al. 2004), el cual contiene los algoritmos necesarios para generar en forma sencilla la información requerida.

Datos digitales:

Registro de las gramíneas colectadas en el área de estudio.

Mapa geoestadístico de los estados de Chihuahua, Durango y Zacatecas (marco geoestadístico de INEGI)

Programas de cómputo utilizados:

DIVA-GIS versión 7.1.7.2 (http://www.diva-gis.org/).

GVSIG 1.9 para Vista (http://www.gvsig.org/).

Los herbarios nacionales revisados para los estudios florísticos son: CIIDIR, CHAPA, COCA, ENCB, HUAA, MEXU, RELC, SLPM, UACJ y en el extranjero: ARIZ, NMC, TAES y US, mencionados en los estudios florísticos particulares de cada Estado (Herrera 2001; Herrera y Peterson 2007; Herrera et al. 2010).

Área de estudio

El área de estudio está formada por el territorio de los estados de Chihuahua, Durango y Zacatecas, ubicados en el norte- centro de la republica mexicana, ocupa una superficie de 446 mil km^2 (Fig. 1), y se localiza entre las coordenadas extremas 21°02'24" a 31°46'48" Norte y 109°04'12" a 100°44'24" Oeste.

El área se localiza en las Provincias Fisiográficas: Sierra Madre Occidental, Llanura y Sierras del Norte y parte de la Mesa del Centro (INEG 2000). Por lo tanto, la topografía es variada y accidentada, con variaciones de altitud que va de menos de 500 a 3200 msnm. La ubicación latitudinal así como la distancia e influencia de la zona marina y de las características topográficas de la zona hace que el área de estudio presente una fuerte variación de los factores climáticos como son la temperatura y la precipitación. Dentro del área se presentan lugares de poca altitud donde la temperatura media anual es de 24 a 26°C hasta sitios con gran altitud y con temperaturas medias anuales entre 8 y 10°C. En cuanto a la precipitación, el área de estudio presenta zonas

Fig. 1. Ubicación geográfica del área de estudio.

secas con poca precipitación total anual (200 mm) y zonas subhúmedas con precipitación entre 1000 y 1500 mm anuales. Las características e interrelaciones de los factores hacen que en el área de estudio exista una variedad de comunidades vegetales o tipos de cobertura de suelo, existen áreas con selva baja caducifolia, bosques templados formados con pino y encino principalmente, pastizales naturales, matorrales xerófilos de diferentes tipos como son el matorral desértico micrófilo, matorral desértico rosetófilo, matorral crasicaule; además por las características del suelo se presentan comunidades arbustivas y pastizales de afinidad halófila (INEGI 1998).

1. Distribución de ejemplares colectados

El análisis de distribución de los sitios de las especies se realizó con la elaboración de un mapa de distribución de los sitios de colecta de gramíneas, el número de colectas y la relación de los sitios de colecta con la distancia a carreteras y principales ciudades. El listado florístico de las 535 especies de gramíneas incluidas en este análisis se reportan en Herrera y Cortés (2010).

A. *Análisis de la distribución geográfica de ejemplares colectados.*—Los datos analizados provienen de 8,171 ejemplares de gramíneas colectados en Chihuahua, Durango y Zacatecas por diversos colectores en diferentes fechas y depositados en herbarios nacionales y del extranjero, los cuales fueron revisados críticamente para validar su correcta identificación, organizados y referenciados geográficamente durante la realización de trabajos como: Las Gramíneas de Durango (Herrera 2001), Muhlenbergia (Poaceae) de Chihuahua, México (Herrera y Peterson 2007), *Gramíneas de Zacatecas, México* (Herrera et al. 2010), *Las Gramíneas de Chihuahua (en elaboración) y Listado florístico y aspectos ecológicos de la familia Poaceae para Chihuahua, Durango y Zacatecas, México* (Herrera y Cortés 2010). Con los registros de las colectas se elaboró con DIVA_GIS un mapa de distribución de los sitios colectados, carreteras y límites estatales.

B. *Análisis de la relación de los sitios de colecta con los caminos y principales ciudades.*—Con las capas digitales de los sitios de colecta, carreteras y límites estatales se analizó la relación de los sitios de colecta con las carreteras para conocer el sesgo de infraestructura (Hijmans et al. 2000), que podría influir en los resultados de este trabajo. En este análisis por medio del programa de SIG se calculó la distancia entre cada sitio de muestreo con la

carretera más cercana y los datos obtenidos fueron organizados por la distancia desde la carretera y el número de sitios de colecta. Además, se calculó la distancia entre cada sitio y las ciudades de Chihuahua, Durango, Fresnillo y Zacatecas y los resultados fueron organizados según la distancia encontrada.

C. Análisis de número de ejemplares colectados.—Este análisis de inicio en DIVA-GIS con la capa de puntos (en formato shapefile) correspondientes a los 8,171 ejemplares colectados con los que se formó una rejilla con 214 cuadros de 30´ de latitud por 30´ de longitud, y se determinó el número de ejemplares colectado en cada cuadro.

2. Riqueza de especies y diversidad

Se estimaron índices de diversidad alfa con el Índice Shannon y el Índice de Margalef para evaluar la riqueza de especies. Estos índices, indican la riqueza de especies de una comunidad particular a la que se considera homogénea y con un método basado en la cuantificación del número de especies presentes (Moreno 2001[a]). Esta forma de analizar la diversidad es muy conveniente ante la rápida transformación de los ecosistemas naturales, ya que ayuda a monitorear el efecto de los cambios en el ambiente tanto en comunidades naturales y modificadas (Moreno 2001b).

A. Análisis de riqueza de especies.—La riqueza de especies se determinó de manera similar al número de ejemplares, con el programa Diva-GIS se generó una primera rejilla indicando el número de especies en cada unos de los 214 cuadros.

B. Análisis de distribución latitudinal de especies.—Se realizó un proceso con Diva-GIS para conocer la variación del número de especies por cada grado de latitud para lo que se formó una rejilla dividida cada grado de latitud con el número de especies presentes.

C. Análisis de diversidad.—El análisis de diversidad de tipo alfa (Moreno 2001[a]) se realizó con algoritmos de diversidad del programa Diva-GIS a nivel de cada cuadro aplicando los índices (Tabla 1).

RESULTADOS

1. Distribución de ejemplares colectados.

A. Distribución geográfica de ejemplares colectados.—Se obtuvo un mapa con los sitios de colecta de 8,171 ejemplares de gramíneas incluidas en el presente análisis, indicando las carreteras pavimentadas, terracerías y límites estatales (Fig. 2). Las especies de importancia (endemismos, escasas, específicas de un tipo de vegetación, introducidas y acuáticas o subacuáticas) se citan en Herrera y Cortés (2010), donde además se puede consultar la Tabla 1 que contiene todos los taxa (535) encontrados en esta región, con datos de comunidades vegetales en que se encontraron, origen, subfamilia a la que pertenecen y Estados de esta región donde se encontraron ejemplares.

B. Relación de los sitios de colecta con los caminos y principales ciudades.—En el mapa (Fig. 2) se observa que los sitios de colecta están cercanos a las principales vías de comunicación y grandes ciudades como Chihuahua, Durango, Fresnillo y Zacatecas. Como resultado del análisis de la relación de los sitios de colecta y la red de carreteras se obtuvo que la mayoría de los sitios se encuentran localizados a menos de 2 km de distancia. En la Figura 3 se aprecia que la mayor frecuencia de sitios está a menos de 200 m de los caminos principales y que disminuye conforme aumenta la distancia, principalmente a distancias mayores de 2 km.

También se obtuvo como resultado que los sitios se encuentran en mayor porcentaje a menos de 250 km de las ciudades de Chihuahua, Durango, Fresnillo y Zacatecas, como puede observarse en la Figura 4.

Esta cercanía a los principales caminos y ciudades provoca un sesgo conocido como sesgo de infraestructura (Hijmans et al. 2000) que repercute en los resultados de diversidad y distribución de las especies de gramíneas que se generaron en este trabajo.

C. Número de ejemplares colectados.—Como resultado del análisis de los ejemplares colectados se encontró que algunas áreas (celdas de la rejilla) están muy colectadas mientras que otras celdas no presentan ejemplares colectados. Así, encontramos (Fig. 5) que 45 celdas (22.8% del área) no presentan ninguna colecta, 24 celdas (12.2%) presentan 1 a 5 ejemplares colectados, 25 celdas (12.7%) con 6 a 10 ejemplares, 82 celdas (41.6%) con

Tabla 1. Fórmulas para estimar los índices de diversidad utilizados.

Índice	Fórmula
Shannon	$H' = -\Sigma p_i \ln p_i$
Margalef	$D_{Mg} = (S - 1) / \ln(N)$

S - número de clases únicas por celda (especies)
N - número de observaciones por celda
n_i - número de individuos en la clase i-ésima
p_i - abundancia proporcional a la clase i-ésima = n_i / N

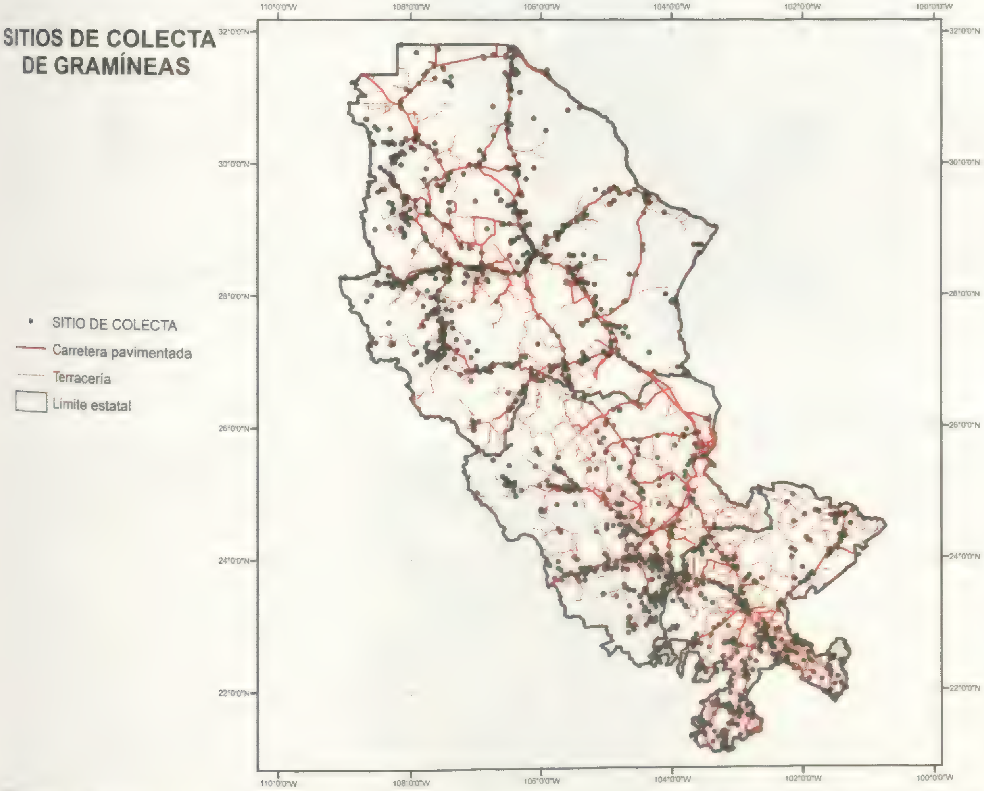

Fig. 2. **Mapa de sitios de colecta de las gramíneas en el área de estudio.**

11 a 100 1ejemplares, 14 celdas (7.1%) con 101 a 200 ejemplares, 5 celdas (2.5%) con 200 a 300 ejemplares, 1 celda (.5%) con 301 a 400 y otra (0.5%) con 401 a 506 ejemplares colectados. Esta distribución de ejemplares colectados se nota sesgada como se plantea en las secciones anteriores, por la presencia de grandes ciudades y otros sitios de interés biológico sobre-muestreados como son: la Reserva de La Michilia, el Parque Nacional Cascada Basaseachi y la Barranca del Cobre en Batopilas, Chihuahua.

2. Riqueza de especies y diversidad

Se obtuvieron datos y mapas de riqueza de especies y del índice de diversidad, en dichos mapas se ven estos dos indicadores en forma clara y se puede apreciar la influencia del sesgo producido por la distribución de las colectas.

Fig. 3. Número de sitios de colecta según la distancia a las carreteras.

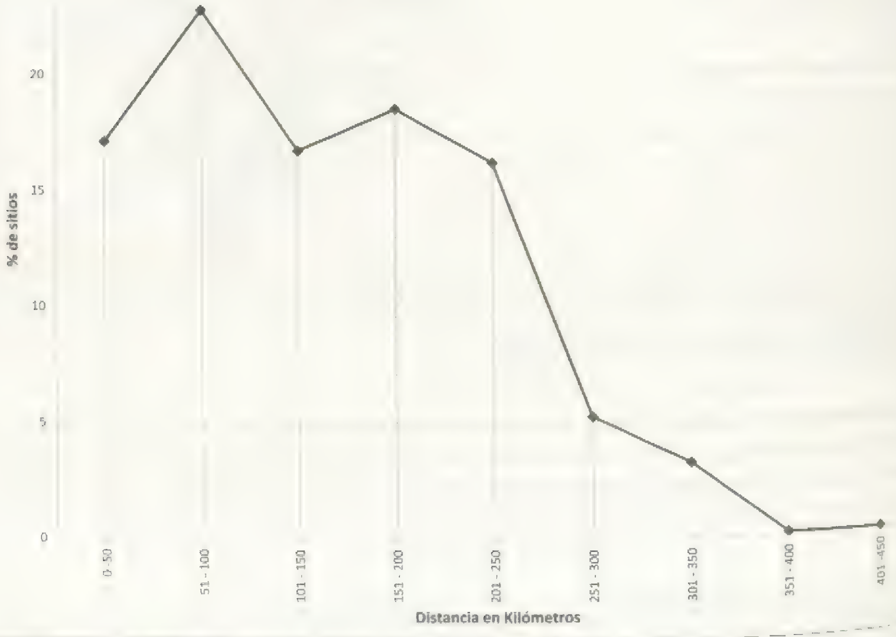

Fig. 4. Distancia desde los sitios de colecta a las principales ciudades del área de estudio (Chihuahua, Durango, Fresnillo y Zacatecas).

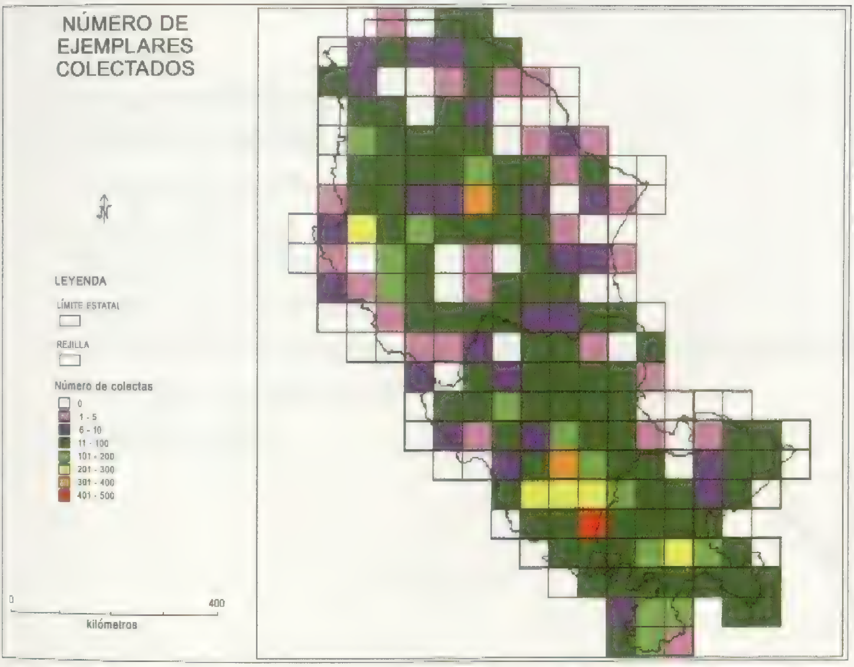

FIG. 5. Mapa con la rejilla de cuadros de 30 × 30 minutos y con la distribución de ejemplares colectados.

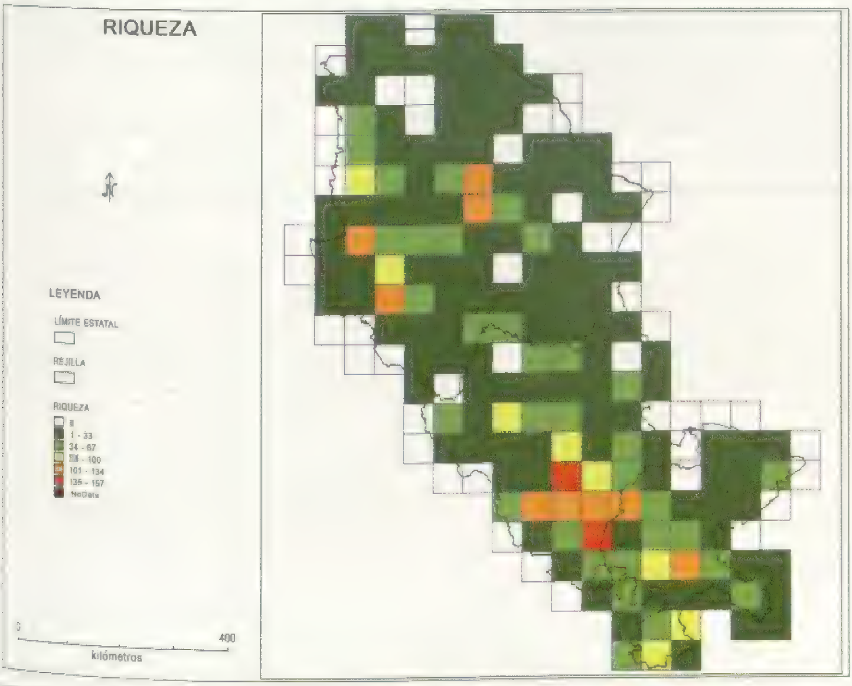

FIG. 6. Mapa de riqueza de especies.

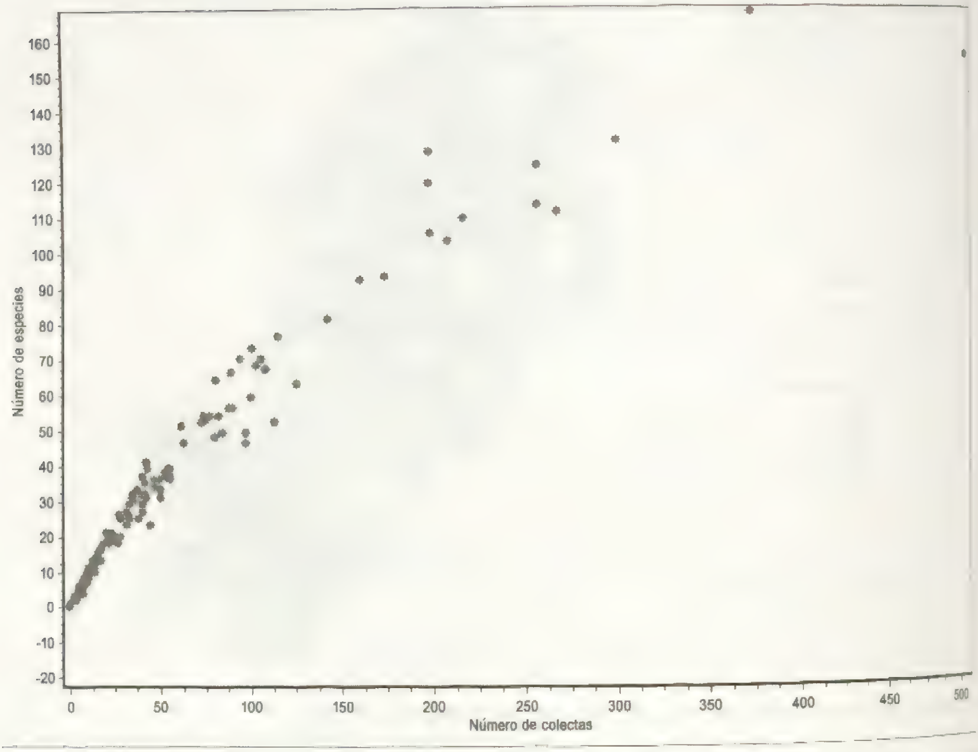

Fig. 7. Proyección del modelo de acumulación de especies de dependencia lineal entre número de muestras o colectas y el número de especies registradas en los cuadros.

Tabla 2. Número de especies (riqueza de especies) y número de cuadros del área de estudio.

Número de especies	Cuadros
0	47
1–33	115
34–67	33
68–100	8
101–134	9
135–167	2
Total	214

A. Análisis de riqueza de especies.—En cuanto a la riqueza de especies, es decir el número de especies en cada cuadro, se obtuvo el mapa de la Figura 6, se observa que la mayoría del área presenta pocas especies colectadas menos de 33 especies y sólo en algunas áreas hay hasta 167 especies de gramíneas. También hay 47 cuadros en que no se han realizado colectas (Tabla 2).

Con la cuantificación de colectas y riqueza de especies fue posible determinar la relación entre ambas cantidades como se muestra con la proyección del modelo de acumulación de especies con dependencia lineal. Estos resultados muestran (Fig. 7) que entre más colectas se han realizado mayor es el número de especies registradas en cada uno de los cuadros. Una aplicación de esta función es en la planeación del trabajo de campo, ya que permite conocer el esfuerzo de colecta requerido para añadir un determinado número o porcentaje de especies a la muestra (Moreno & Haffter 2000).

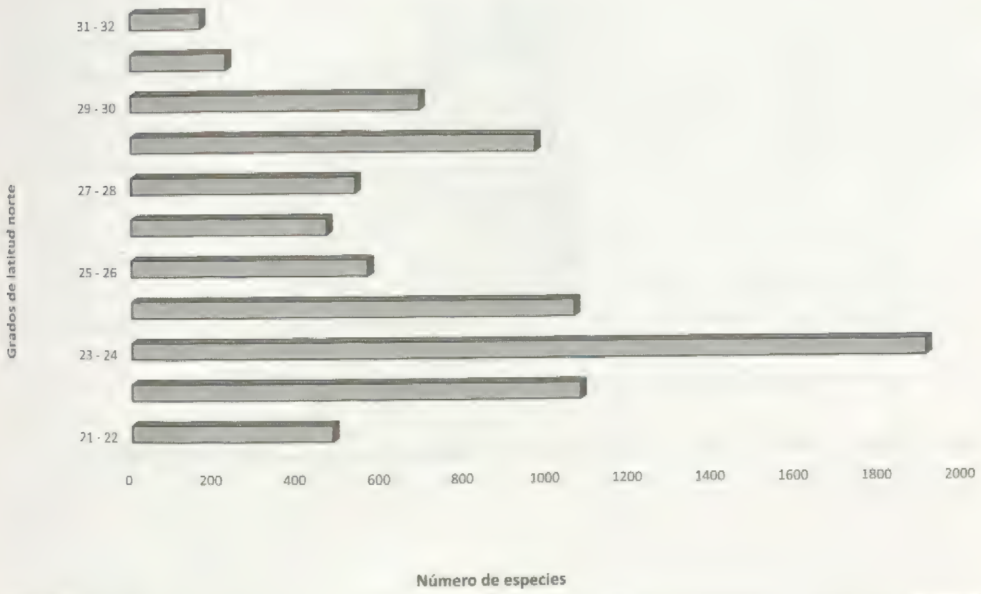

Fig. 8. Frecuencia de especies de gramíneas registradas según la latitud.

B. *Análisis de distribución latitudinal de especies.*—El número de especies registradas varía con la latitud de tal manera que los cuadros ubicados en los intervalos 23°–24° N y 28°–29° N presentan mayor número de especies (Fig. 8). La ciudad de Durango se ubica a una latitud de 24°01'N y la ciudad de Chihuahua en la latitud de 28°38'N, lo que confirma la existencia del sesgo ocasionado por una frecuencia de muestreo mayor cerca de las principales ciudades del área de estudio. Gaston y Spicer (2004) establecen la consideración muy generalizada de que, "la riqueza de especies de la mayoría de los grupos de organismos se incrementa desde las altas latitudes (templadas) hacia las bajas latitudes (tropicales)", condición que no se cumple en este análisis por el fuerte sesgo que se presentan los datos de distribución de los sitios de colecta, que hace que no se cumpla la observación generalizada.

C. *Análisis de diversidad.*—Al determinar los índices de diversidad con el programa Diva-GIS se generó el mapa de la Figura 9, el cual indica para el índice de Shannon valores que van de 0 a 5. Los valores más altos (5) se presentan cerca de la ciudad de Durango, en el Valle del Guadiana y en la región de la zona de Reserva de la Biosfera La Michilia. Otra zona con valores altos corresponde a la región del municipio de Chihuahua, Chih. Una tercera zona con valores altos del índice de Shannon es el área que comprende los municipios de Batopilas, Guachochi y Urique, Chih., en donde se localiza las Barrancas del Cobre y el Parque Natural Cascada Basaseachi. Mientras que los cuadros con valores de 3 y 4 de Índice de Shannon son cruzados por las principales carreteras existentes en el área de estudio y con tipos de vegetación de bosques y pastizales naturales. Todo ello indica un sesgo por mayor número de colectas y de especies. Las áreas con vegetación xerófila presenta principalmente valores de 2 a cero por pocas colectas y pocas especies registradas.

El mapa generado con el Índice de Margalef (Fig. 10) muestra los cuadros representados con los valores del índice que van de 1 a 28, los cuadros con valores de 23 a 28 representados con el color rojo corresponden a la ciudad de Durango, ciudad Chihuahua, zona de la Barranca del Cobre y la Reserva de la Biosfera La Michilia. También se observa que los cuadros con valores de 5 a 22 corresponden a las áreas que presentan carreteras pavimentadas por lo que presentan cierta frecuencia de colectas realizadas.

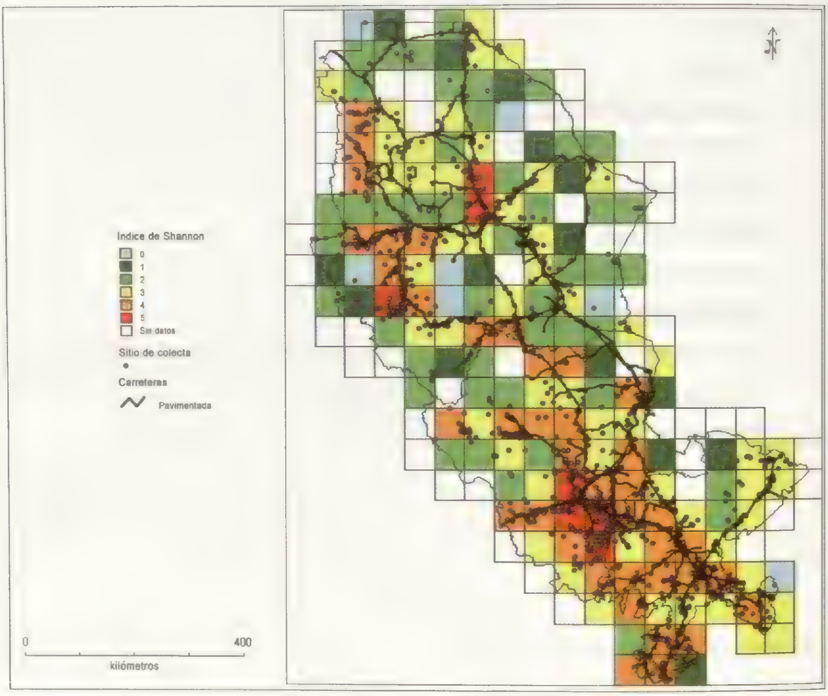

FIG. 9. Mapa de cuadricula con el Índice de Shannon en cada cuadro de estudio.

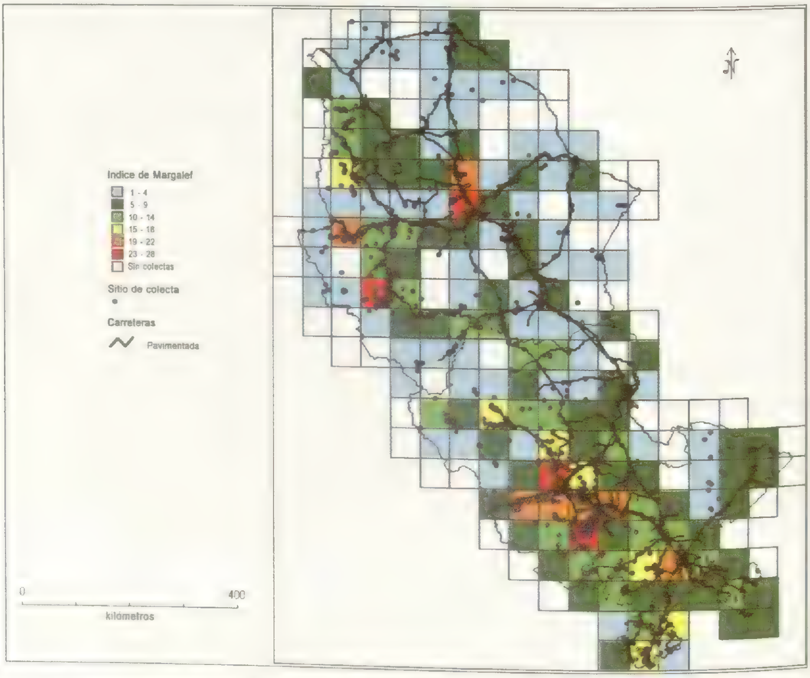

FIG. 10. Mapa con el Índice de Margalef determinado para cada cuadro del área de estudio.

DISCUSION Y CONCLUSIONES

En este trabajo fue posible conocer cómo se encuentran distribuidas espacialmente las gramíneas en los estados de Chihuahua, Durango y Zacatecas, México. Fue posible analizar la ubicación de los sitios de colectas en relación a las principales vías de acceso terrestre y a las principales ciudades del área de estudio. Se encontró que la mayor densidad de sitios de colecta se ubican cerca de: a) las principales carreteras pavimentadas, b) las grandes ciudades existentes en el área de estudio y c) de regiones protegidas como Parques Nacionales o Reservas Naturales. Resultado que responde a la serie de colectas realizadas cerca de las ciudades capitales de los Estados desde finales del Siglo XIX a la fecha, y a los estudios e investigaciones aplicados a sitios de interés particular como son las regiones protegidas (Rancho La Campana, Barranca del Cobre, Cascada Basaseachi). Así también se percibe la escasez de colectas o ausencia total de ellas en lugares alejados de poblaciones, carreteras pavimentadas y caminos, lo que ocasiona claramente un sesgo a considerar en los resultados de distribución y diversidad de la familia Poaceae (gramíneas) de esta región. Dicho sesgo fue evidente al analizar: a) la riqueza de especies, b) la distribución latitudinal, y c) la diversidad estimada con los índices de Shannon y de Margalef; por lo que se tienen dudas sobre la fiabilidad de los resultados.

Se concluye que: 1) los datos de distribución de especies tomados de ejemplares colectados con fines de estudios florísticos, deben ser complementados con colectas adicionales, que den homogeneidad a la frecuencia de colectas; con el fin de lograr una mejor interpretación de la distribución de riqueza de especies y diversidad florística. 2) existen lugares poco o nada colectados que sobresalen y se indican en un estudio de este tipo (ver Fig. 5, cuadros en blanco sin colectas, cuadros en rosa con 1 a 5 especies y cuadros en púrpura con 6 a 10 especies), para ser tomados en cuenta por los estudiosos de la taxonomía o de cualquier otro aspecto de la biodiversidad. 3) estas técnicas de análisis espacial permiten obtener información útil sobre la diversidad y para futuras colectas, a pesar del sesgo mostrado. 4) este estudio muestra la utilidad de la aplicación de las técnicas con fines de manejo y conservación de las especies estudiadas.

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ALPINE FLORA OF CERRO MOHINORA, CHIHUAHUA, MEXICO

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ABSTRACT

An annotated, vouchered checklist for the only known alpine-subalpine plant community in the Sierra Madre Occidental of Mexico, Cerro Mohinora of southwest Chihuahua, is presented. Contrary to former reports of a sparse timberline vegetation on Cerro Mohinora, we document a relatively diverse vascular flora, including 79 species that represent 63 genera and 33 families. Based on the species composition of this flora, the vegetation shares minimal biogeographic affinities with alpine vegetation in the Sierra Madre Oriental of Northeast Mexico (7.2% Sorensen Index; comparing Mohinora with the collective floras of Sierra La Viga, Coahuilon, Cerro Potosí, and Peña Nevada). Only nine timberline species of Mohinora occur in similar habitats in the high mountains of northeast Mexico, suggesting enduring isolation through time, even during pluvial periods of the Pleistocene. Cerro Mohinora shares about half that index of similarity with alpine vegetation in Mexico's volcanic belt (3.6% Sorensen Index; comparing Mohinora with the collective floras of Popocatepetl, Iztaccihuatl and Nevado de Toluca).

RESUMEN

Se presenta un listado florístico basado en colecciones vegetales para el único refugio alpino conocido en la Sierra Madre Occidental de México, Cerro Mohinora, en el suroeste de Chihuahua. A pesar de reportes históricos que describen una flora con pocas especies en este sitio, reportamos una comunidad vegetal que soporta una flora diversa con 79 especies, 63 géneros, y 33 familias. Basada en la composición de especies de esta flora, la vegetación alpina de Cerro Mohinora demuestra afinidades fitogeográficas mínimas con la vegetación alpina de la Sierra Madre Oriental. Se calcula un índice de similitud de 7.2% (Sorensen) entre la flora de Mohinora y las de Sierra La Viga, Coahuilon, Cerro Potosí, y Peña Nevada. Solamente nueve especies alpinas de Cerro Mohinora se encuentran en las montañas altas del Nordeste de México, indicando un aislamiento permanente, aun durante ciclos pluviales durante el Pleistoceno. La zona alpina de Cerro Mohinora demuestra aun menos afinidades con floras similares en la zona neovolcánica, demostrando un índice de similitud (Sorensen) de 3.6% entre la zona alpina de Mohinora y los zacatonales de Popocatepetl, Iztaccihuatl y el Nevado de Toluca.

INTRODUCTION

Studies on the alpine floras of Mexico focus primarily on highly specialized timberline elements that inhabit basaltic substrates above 4000 m on the 19° latitude parallel (Zone III, Fig. 1), including those of the Cofre de Perote, Iztaccihuatl, Malinche, Nevado de Colima, Nevado de Toluca, Pico de Orizaba, and Popocatepetl (Purpus 1907; Beaman 1962, 1965; Lauer & Klaus 1975; Narave 1985; Almeida-Leñero et al. 1994, 2004; Gimenez de Azcarate & Escamilla 1999). Beaman & Andresen (1966) expanded the scope of alpine studies by comparing the floristic composition of these volcanic peaks with an isolated community of alpine plants in Northeast Mexico, where timberline communities of Cerro Potosí occur on limestone substrates in the Sierra Madre Oriental of Nuevo Leon. This northern site exhibits closer phytogeographic affinities to forb-dominated montane plant communities of the southern Rocky Mountains than with grass-dominated, timberline vegetation ('zacatonales') across Mexico's volcanic belt (Beaman 1965; Rzedowski 1975; Narave 1985; Almeida-Leñero et al. 2004). Later explorations of Northeast Mexico by McDonald (1990, 1993) discovered six additional alpine sites in the region (three sites indicated in Fig. 1 on account of the close proximity of four timberline zones), between which a considerable number of autochthonous (McDonald 1993, Table 23.1), narrow endemic species occur.

None of the aforementioned studies make reference to the reconnaissance work of Donovan Correll (1960) and Howard Scott Gentry on an isolated peak of the Sierra Madre Occidental in Southwest Chihuahua (Fig. 1), Cerro Mohinora (25°57'29.31"N, 107°02'56.37"W), where Goldman (1951) had observed in 1898 a

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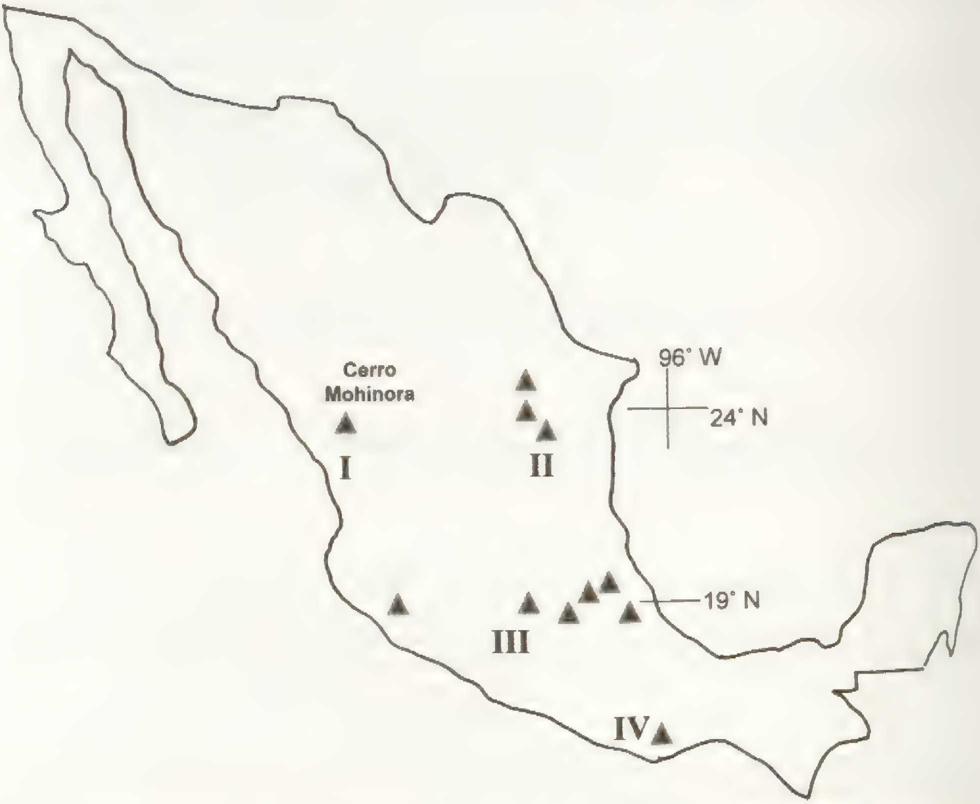

Fig. 1. Contemporary distribution of alpine-subalpine floras in Mexico. A single, relictual timberline vegetation occurs in the Sierra Madre Occidental (Zone I: Cerro Mohinora), as compared to a series of closely situated alpine refugia in the Sierra Madre Oriental (Zone II). The central volcanic belt traversing the 19° lat. meridian (Zone III) and an isolated, highly restricted alpine/subalpine site on Cerro Quiexobra of the Sierra Madre del Sur (Zone IV, in prep) harbor isolated and uniquely derived timberline vegetation.

snow-capped summit with stunted trees and 'open' forest. Arriving on the 16th of October, 1959, Correll reported a "disappointingly sparse" vegetation dominated by herbs and grasses on Cerro Mohinora's precipitous, rocky substrates (maximum altitude reports ranging from 3319–3900 m; Webb & Baker 1984). He attributed the peak's poor floristic composition to either goat grazing or a heavy frost that had already fallen by the time of his late arrival.

In recognition that the timberline vegetation of Cerro Mohinora had yet to be observed during the peak of flowering in late summer, the site was visited during the last two weeks of August in 1987 and 1988 by the authors to assess the floristic composition of the Sierra Madre Occidental's only known timberline flora. We observed a colorful and species-rich alpine vegetation on approximately 15 hectares upon the mountain's bald and adjacent declivities. Forbs and grasses dominate the timberline vegetation, representing 33 families, [illegible] genera, and 79 species, with an occasional intrusion of stunted pines (*Pinus cooperi* Blanco), junipers (*Juniperus blancoi* Martinez var. *huehuetentensis* R.P. Adams) and aspen (*Populus tremuloides* Michx.). The Asteraceae and Poaceae harbor more species than other vascular plant families (14 and 7 spp., respectively), followed by the Caryophyllaceae (4 spp.), Plantaginaceae (4 spp.), Apiaceae (3 spp.), Crassulaceae (3 spp.) and Primulaceae (3 spp.).

While the timberline floras of the Sierra Madre Oriental and Sierra Madre Occidental cover no more than

6 sq. kms in the present day, McDonald (1993) estimated approximately 5% of Mexico was covered by alpine vegetation during pluvial cycles of the Pleistocene. Based on the hypothesis that timberlines descend in altitude by around 1000 m during glacial cycles, the Sierra Madre Occidental likely harbored the largest, continuous extensions of timberline vegetation in Mexico during ice ages, ranging from central Sonora to southern Durango (McDonald 1993). In the present age, this refugium of highly specialized vegetation exhibits the narrowest distribution of all of Mexico's alpine habitats.

In anticipation of a comprehensive examination of the origins, floristic relationships, endemic composition, and historical biogeography of alpine vegetation throughout Mexico (McDonald & Feria, in prep), we present a floristic list for a rare and vulnerable plant community (by virtue of its narrow distribution) in the Sierra Madre Occidental. We compare this flora with a comparable vegetation type in Northeast Mexico (McDonald 1990) and that of Mexico's volcanic belt (Almeida et al. 2007), computing a 'Sorensen Index of Similarity' of only 7.2% between Cerro Mohinora and timberline vegetation of the Sierra Madre Oriental (SI = 2C/A + B: where A and C equal the number of species found at disjunct sites and C equals the number of species found at both locations). In comparing the floras of Cerro Mohinora with a floristic list for Popocatepetl, Iztaccihuatl, and the Nevado de Toluca, the Sorensen Index computes to a mere 3.6% similarity. In both cases, floristic evidence indicates that the cyclic expansion of alpine vegetation during pluvial periods of the Pleistocene allows for only limited floristic exchange between the Sierra Madre Occidental and other tall mountains of Mexico. These data add further support to the general assumption that timberlines descend around 1000 m during glacial maxima.

Given the distinctive and rare character of Cerro Mohinora's plant communities, the summit and ecologically intact surroundings merit some form of conservation status. It is noteworthy that only a single non-native species (*Poa annua*) was encountered in the region during the late 1980s, indicating a relatively pristine flora, albeit affected by the grazing of goats during the 1950s (fide Correll) and cows during our two forays. A road now leads to the top of the mountain to serve a microwave tower, thereby encouraging and facilitating increased human activities in this isolated region. Foresight and planning might protect this rare, endemic, and predictably fragile vegetation type from fires, grazing, trail erosion, and other forms of ecological damage suffered by alpine zones throughout Mexico (Gimenez de Azcarate & Escamilla 1999; Almeida-Lenero et al. 2007).

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

Collector names are abbreviated as follows: **DSC** = Donovan S. Correll (TEX); **GN** = Guy Nesom (TEX); **HSG** = Howard S. Gentry (TEX); **JM** = Jorge Martínez (HUAA, XAL); **JAM** = J. Andrew McDonald (HUAA, TEX, XAL). Herbarium acronyms denote location of each collector's specimens.

PTERIDOPHYTA

Woodsiaceae

Woodsia phillipsii Windham; *DSC & HSG 23164*

CONIFEROPHYTA

Cupressaceae

Juniperus blancoi Marti var. *huehuetentensis* R.P. Adams, S. González & M. González Elizondo; *JAM & JM 2351*

Pinaceae

Pinus cooperi Blanco; *JAM & JM 2349*

MAGNOLIOPHYTA

Apiaceae

Eryngium lemmonii J.M. Coult. & Rose; *JAM & JM 2364*

Ligusticum porteri J.M. Coult. & Rose; *JAM & JM 2404, JAM & GN 2471, GN & JAM 6458*

Tauschia edulis (S. Wats.) J.M. Coult. & Rose; *JAM & JM 2357*

Brassicaceae

Pennellia longifolia (Benth.) Rollins; *DSC & HSG 23167, JAM & JM 2353, JAM & GN 2480*

Draba rubricaulis Heller; *DSC & HSG 23160, JAM & JM 2405*

Caryophyllaceae

Arenaria lanuginosa (Michx.) Rohrb.; *DSC & HSG 23187, JAM & JM 2350, 2408, JAM & GN 2478*

Drymaria effusa var. *depressa* (Greene) J. Duke; *JAM & JM 2365*

Cerastium nutans Raf.; *JAM & JM 2366*

Silene laciniata Cav. var. *greggii* (A. Gray) Hitch. & Maguire; *DSC & HSG 23162, JAM & JM 2382, JAM & GN 2492*

Commelinaceae

Commelina cf. *tuberosa* L.; *JAM & JM 2377*

Tradescantia pygmaea Hunt; *JAM & JM 2378*

Compositae

Ageratina lemmonii (B.L. Rob.) King & Rob.; *JAM & JM 2374*

Correllia montana A.M. Powell; *JAM & JM 2346, JAM & GN 2479*

Dahlia sherffii Sorenson; *JAM & JM 2373*

Erigeron macdonaldii G.L. Nesom; *JAM & GN 2372*

Erigeron mohinorensis G.L. Nesom; *DSC & HSG 23151, JAM & JM 2371*

Erigeron rhizomactis G.L. Nesom; *JAM & JM 234X*

Galinsoga subdiscoidea Cronquist; *JAM & JM 2344, GN & JAM 6478*

Grindelia megalocephala (Fern.) G.L. Nesom; *JAM & JM 2347*
Senecio mohinorensis Greenm.; *DSC & HSG 23146, JAM & JM 2338*
Senecio umbraculifera S. Wats.; *DSC & HSG 23155, JAM & JM 2348*
Senecio scalaris Greenm. var. *scalaris*; *DSC & HSG 23144, JAM & JM 2342*
Stevia plummerae A. Gray var. *plummerae*; *JAM & JM 2339*
Verbesina longifolia A. Gray; *JAM & JM 2337*
Viguiera multiflora S.F. Blake var. *macrocephala* (Heiser) B.L. Turner; *JAM & JM 2375*

Crassulaceae
Sedum jaliscanum S. Wats.; *JAM & GN 2468*
Sedum chihuahuense S. Wats.; *DSC & HSG 23158, JAM & JM 2400, JAM & GN 2477*
Villadia pringlei Rose; *JAM & JM 2379T, JAM & GN 247*

Cyperaceae
Cyperus pennellii O'Neill & Ben. Ayers; *JAM & JM 2356* (XAL)
Cyperus fendlerianus Boeckeler; *JAM & JM 2397* (XAL)

Fabaceae
Lupinus barberi (C.P.Smith) Rafaill & Dunn; *JAM & JM 2354*
Lupinus montanus Kunth subsp. *glabrior* (S. Watson) Dunn & Harmon; *JAM & JM 2359*

Gentianaceae
Halenia recurva (Sm.) Allen; *JAM & JM 2396*
Gentianopsis macrantha (D. Don ex G. Don) Iltis; *DSC & HSG 23143*

Geraniaceae
Geranium wislizeni S. Wats.; *DSC & HSG 23159*
Geranium richardsonii James; *JAM & JM 2380*

Hydrophyllaceae
Phacelia platycarpa Cav.; *JAM & JM 2355*

Iridaceae
Sisyrinchium convolutum Nocca; *JAM & JM 2352*

Juncaceae
Luzula comosa Meyer; *DSC & HSG 23173, JAM & JM 2391, 2481, JAM & GN 2494*

Lamiaceae
Salvia microphylla Kunth; *JAM & JM 2385*
Stachys mohinora B.L. Turner; *DSC & HSG 23181, JAM & JM 2387, JAM & GN 2495*

Liliaceae
Calochortus venustulus Greene; *JAM & JM 2369*

Melianthaceae
Zigadenus cf. *elegans* Pursh; *JAM & JM 2410*

Montiaceae
Montia perfoliata (Donn ex Willd.) Howell; *JAM & JM 2368, JAM & GN 2474*

Onagraceae
Oenothera pubescens Willd. ex Spreng.; *JAM & JM 2367*

Orobanchaceae
Castilleja tenuifolia Mart. & Gal.; *DSC & HSG 23147*
Pedicularis chihuahuensis G.L. Nesom; *JAM & JM 2402*

Oxalidaceae
Oxalis decaphylla Kunth.; *JAM & JM 2409*

Piperaceae
Peperomia campylotropa A.W. Hill; *JAM & JM 2493*

Plantaginaceae
Penstemon barbatus (Cav.) Roth.; *JAM & JM 2386*
Penstemon campanulatus (Cav.) Willd.; *DSC & HSG 17996*
Penstemon mohinoranus Straw; *JAM & JM 2370*
Veronica peregrina L. ssp. *xalapensis* (Kunth) Penn.; *JAM & JM 2399*

Poaceae
Bromus ciliatus L.; *JAM & JM 2393, GN & JM 6474*
Deschampsia flexuosa (L.) Trin.; *DSC & HSG 23179, JAM & GN 2482*
Festuca hintoniana Alexeev; *JAM & GN 2475, 2489*
Festuca diclina S.J. Darbyshire; *JAM & JM 2392*
Koeleria pyramidata (Lam.) Beauv.; *DSC & HSC 23175, JAM & JM 2394*
Poa annua L.; *JAM & JM 2358*
Trisetum filifolium Scribn. ex Beal; *DSC & HSG 23176*

Polygonaceae
Rumex acetosella L.; *JAM & JM 2363*

Primulaceae
Dodecatheon pulchellum var. *pulchellum* (Raf.) Merr.; *JAM & GN 2490, GN & JAM 6460*
Dodecatheon ellisieae Standl.; *GN & JAM 6471*
Primula rusbyi Greene; *JAM & JM 2406, GN & JAM 6469*

Ranunculaceae
Ranunculus gentryanus Benson; *DSC & HSG 23156, JAM & JM 2362*
Thalictrum grandifolium S. Wats.; *JAM & JM 2383, JAM & GN 2470, GN & JAM 6457*

Rosaceae
Alchemilla aphanoides L.f.; *JAM & JM 2381*
Holodiscus discolor (Pursh) Maxim. var. *discolor*; *DSC & HSG 23182, JAM & JM 2403*

Rubiaceae
Galium uncinulatum DC.; *JAM & GN 2401, 2476*
Galium mexicanum Kunth subsp. *asperrimum* (A. Gray) Dempster; *JAM & JM 2388*

Salicaceae
Populus tremuloides Michx.; *DSC & HSG 23186*

Saxifragaceae
Heuchera sp. *JAM & JM 2389*
Saxifraga eriophora S. Wats.; *JAM & JM 2407*

Solanaceae
Solanum stolonifera Schtdl. & Bché; *JAM & JM 2389, 2420*
Solanum demissum Lindl.; *JAM & GN 2469*

Valerianaceae
Valeriana deltoidea Meyer; *JAM & JM 2361*

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BOOK REVIEW

Ashok Gadgil, Lawrence Berkeley, and Diana M. Liverman (eds.). 2010. **Annual Review of Environment and Resources, Volume 35, 2010.** (ISBN: 978-0-8243-2335-6, hbk.). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $80.00, 389 pp., 7 ⅝" × 9 ⅜".

The *Annual Review of Environment and Resources, Volume 35*, edited by Ashok Gadgil and Diana M. Liverman, is an in depth overview of current scientific and policy issues concerning environment, development, and resource management. It is a collection of papers by leading experts examining emerging research in their respective fields and highlighting a range of critical issues.

The review targets practitioners, policy makers, and scholars in the environmental and policy fields who wish to be current on a particular subject, but who perhaps do not have time to consult the multiple journals and periodicals necessary to gather the required information. The editors also state that the *Review* targets "non-scientists charged with making sense of changing environmental issues." While non-scientists will benefit from the in-depth information available in the review, a number of the articles would require great persistence on the part of a non-scientist to glean and synthesize the desired information.

The *Review* is divided into three major sections. The first section, "Earth's Life Support Systems," offers three articles addressing a variety of issues dealing with the ecological impact of human activity on the natural world. The authors examine how humans have substantially altered natural ecosystems and discuss the need to identify and implement a variety of management options to control negative impacts.

The second section, "Human Use of Environment and Resources," provides a wide variety of in-depth analyses of the human behaviors that drive environmental degradation. Five articles address energy, water, agriculture, urbanization, and environmentally friendly or "green" consumption patterns. The articles provide insights on the socio-economic drivers of human behavior and the respective consequences of that behavior on the resource base at local, national, and international levels. The authors offer a variety of scenarios for future research and change.

The third section, "Management, Guidance, and Governance of Resources and Environment," makes the link to policy and governance with five articles linking human behavior and environmental degradation to the decision making arena. This section examines the global interconnectedness of human impact on the environment and analyzes the enormous socio-economic, institutional, and political complexities involved in resolving environmental issues.

Four reoccurring themes rise to the surface when reviewing this compilation of articles—vulnerability, resilience, adaptation, and rescaling. All of the articles address one or more of these characteristics. To highlight just a few, in the first section, authors Donald Strong and Kenneth Frank address issues of vulnerability and resilience of food webs. The authors argue that the human impact on food webs and the subsequent loss of large "apex" predators on land and in water has drastically altered producer/consumer relationships and the ecosystems that sustain them. They also challenge future researchers to focus on less conspicuous organisms in a food web as their plight may shed light on the ecosystem as a whole. Author, Klaus Kümmerer, examines human and environmental vulnerability to the deposition and transformation of pharmaceuticals in aquatic environments. He states that the health risk to humans is poorly understood and makes the case for better handling and use of pharmaceuticals at the source as well as for improved biodegradable pharmaceuticals.

Review continued on page 718

ANÁLISIS FLORÍSTICO DE UN PASTIZAL DEL ESTADO DE QUERÉTARO, MÉXICO

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RESUMEN

Se presenta un estudio florístico de un pastizal del estado de Querétaro, México. En este pastizal se identificaron tres asociaciones vegetales (pastizal-encinal, cacto-*Acacia*-pastizal y pastizal abierto) y se registraron 41 familias, 111 géneros, 142 especies, ocho variedades y tres subespecies. Asteraceae, Fabaceae y Poaceae son las familias con mayor riqueza de especies. Del total de especies, el 92% son nativas; 8% son introducidas; 27% son endémicas de México; 2% son naturalizadas y 39% se comportan como malezas ruderales o arvenses, o son plantas invasoras en las que su presencia se puede interpretar como indicadoras de disturbio, de sobrepastoreo, de vegetación secundaria y/o de erosión. En la flora del pastizal se identificaron once formas de vida. Las herbáceas predominan aportando poco más de la mitad (53%) de la riqueza de especies y junto con los arbustos y las rizomatozas proporcionan casi el 85 % de la flora del pastizal. A pesar de la ubicación, la superficie y el pastoreo excesivo, la riqueza florística, la riqueza de formas biológicas y el porcentaje de endemismo son sustantivos, así también el porcentaje de flora nativa que alberga este pastizal, es alto. Actualmente, el pastizal comienza a mostrar algunos signos de deterioro provocados por el uso irracional de sus recursos.

PALABRAS CLAVE: formas de vida, México, pastizal, Querétaro, riqueza

ABSTRACT

A floristic study of grassland from the state of Queretaro, Mexico is presented. In this grassland, three vegetation associations (grassland-oak, cactus-*Acacia*-grassland, and open grassland), 41 families, 111 genera, 142 species, 8 varieties, and 3 subspecies were recorded. Asteraceae, Fabaceae and Poaceae are families with the greatest species richness. Of the total taxa, 92% were considered native, 8% introduced, 27% endemic to Mexico, 2% naturalized, and 39% weedy or invasive. Weedy plants were indicative of disturbed regions, overgrazed areas, secondary vegetation, and areas of soil erosion. Eleven growth forms were identified within the grassland, with herbaceous species representing 53% of the species richness, and along with the shrubs and the rhizomatous individuals, representing almost 85% of the grassland flora. In spite of the location, area and intensive overgrazing, this grassland displays a substantial richness of biological forms and a high level of endemism and native species. At present, the grassland is showing signs of ecological degradation due to intensive over use of the land.

KEY WORDS: life forms, Mexico, grassland, Queretaro, richness

INTRODUCCIÓN

Los pastizales son comunidades vegetales donde las especies dominantes son gramíneas perennes con exclusión total o parcial de árboles y arbustos (Zamudio et al. 1992). Estos ambientes son ricos en microclimas (que aumentan en relación con la complejidad de la topografía), flora, fauna y microorganismos (Coupland 1979) y su presencia está determinada por condiciones climáticas, edáficas, topográficas, la actividad antrópica y la herbivoría (Moore 1982).

Algunos pastizales mexicanos son el resultado de largos e intensos periodos de actividad antrópica que se desarrollaron en áreas que originalmente pudieron haber estado cubiertas por bosque de *Pinus* y *Quercus* (Rzedowski 1975) y otros, se han establecido en áreas de matorral xerófilo. Los pastizales alpinos y subalpinos tienen distribución restringida a las montañas del centro y sur de México. Los pastizales de zonas áridas o semiáridas son importantes porque albergan un alto porcentaje de especies endémicas y representan la mayor

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proporción de pastizal natural en México. Asimismo, existen pastizales determinados por condiciones de suelo y deficiencias en el drenaje y aquellos vinculados con afloramientos de rocas sedimentarias ricas en carbonato de calcio (Rzedowski y Calderón de Rzedowski 1995). Así entonces, los pastizales se agrupan en tres categorías: climáticos, edáficos y antropógenos.

Los pastizales se distribuyen, en todos los continentes, entre las latitudes de 60°N y 50°S, área que equivale a 20% del total de tierra emergida (Moore 1982). En México, estos pastizales ocupan de 10 a 12% del territorio y están mejor representados en el noroeste y la zona semiárida del centro (Rzedowski 1975). En el estado de Querétaro, cubren 4.5% de la superficie y se ubican en el llamado rincón meridional de Querétaro (Zamudio et al. 1992) en los municipios Amealco, San Juan del Río y Huimilpan. Pequeños manchones aislados de pastizal se localizan en los municipios El Marqués, Colón, Cadereyta y Ezequiel Montes. Esto representa una gama de pastizales bajo diferentes condiciones ecológicas y con diferencias en la composición y diversidad florística. Los pastizales son comunidades cada vez más vulnerables debido a factores como las sequías, el fuego, la invasión de especies exóticas así como por la intervención del hombre mediante las prácticas de pastoreo no planeado y la apertura de áreas para terrenos de cultivo, lo que está causando la desertificación de dichas comunidades. Un estudio florístico es fundamental para conocer la riqueza de especies vegetales y la base para generar y establecer estrategias de restauración, manejo y conservación de los recursos vegetales. En este ámbito se estudió la composición florística de un pastizal al sur del estado de Querétaro, México.

MATERIALES Y MÉTODOS

El estado de Querétaro se localiza en el centro-este de México entre las coordenadas 20°01'16" y 21°35'38" de Latitud Norte y 99°00'46" y 100°35'46" de Longitud Oeste. La forma de su territorio se muestra a manera de un girón alargado y angosto que lo convierte en una especie de transecto que va en sentido NE-SO (Fig. 1). El área de estudio pertenece a la subprovincia de Llanuras y Sierras de Querétaro e Hidalgo que se incluye en la región fisiográfica del Eje Neovolcánico (Fig.1A). Esta área se localiza a 2.7 km al sur de la cabecera municipal del municipio Huimilpan, sobre la carretera estatal Querétaro-Huimilpan (Fig. 1B) y se ubica a los 20°24'68" de LN y 100°15'17" de LW , con una altitud promedio de 1980 msnm. Este pastizal tiene una superficie de 3.3 km^2 que asemeja un rectángulo (Fig. 1C). El suelo es de tipo vertisol pélico con litosol y de textura fina en fase lítica con lecho rocoso entre 100 y 50 cm de profundidad (Anónimo, 1986). El clima es templado subhúmedo con lluvias en verano C(w$_1$)(w) según la clasificación de Köppen modificada por García (1981).

El área se definió a partir de los datos originados por Zamudio et al. (1992) y mediante la cartografía editada por el Instituto Nacional de Estadística, Geografía e Informática (Anónimo 1986). La superficie total se obtuvo tomando las coordenadas en cuatro puntos de referencia en el área de estudio con un geoposicionador (GPS) estableciéndose cuatro anclas o mojoneras (20°24'68"N y 100°15'17"O, 20°25'02"N y 100°15'31"O, 20°23'61"N y 100°16'11"O, 20°24'77"N y 100°16'08"O). Estos datos se insertaron en el software AutoCad-12 y con la carta topográfica "La Estancia" F-14-C-76, Guanajuato-Querétaro (Anónimo 1997) en escala 1:50,000 se digitalizó el área con una tableta digitalizadora en coordenadas UTM, en kilómetros.

Durante dos años, se hicieron dos recolectas mensuales intensificándose durante la estación lluviosa y los ejemplares botánicos se depositaron en el herbario QMEX. También se consideraron recolectas previas obtenidas de la revisión de los herbarios CHAPA, ENCB, IEB y MEXU (Holmgren et al. 1990). La identificación de las especies se hizo mediante diversas obras florísticas (McVaugh 1983; Clayton y Renvoize 1986; Davidse et al. 1994; Mickel y Smith 2004; Calderón de Rzedowski y Rzedowski 2005; diversas obras especializadas en los grupos taxonómicos de monocotiledóneas y dicotiledóneas). La nomenclatura se actualizó con base en Dahlgren et al., 1985; Clayton y Renvoize (1986), Espejo-Serna et al. (2000), Valdés-Reyna y Barkworht (2002); Mickel y Smith 2004; Dávila et al. (2006), el catálogo de Gramíneas del Nuevo Mundo y la base de datos de plantas vasculares contenidos y actualizados permanentemente por el Missouri Botanical Garden vía internet (http://mobot.org/W3T/Search).

RESULTADOS Y DISCUSIÓN

Riqueza florística

La riqueza florística del pastizal (Cuadro 1, Apéndice) consta de 41 familias, 111 géneros y 142 especies además de ocho variedades y tres subespecies. Las Pteridofitas aportan el 5% del total de la flora. De las Magnoliophyta, las Liliopsida conforman 27% de la flora y las Magnoliopsida, con 68%, son las más numerosas pues son las plantas más diversificadas y forman siempre el mayor grupo.

Asteraceae (20/23), Fabaceae (12/14) y Poaceae (20/28) contribuyen con mayor riqueza de géneros y también mayor riqueza de especies. Estas familias reúnen 40% (62) de los géneros y 46% (65) de las especies de la flora total del pastizal (Apéndice). Esta composición cuantitativa y la predominancia de estas familias constituye un aspecto muy peculiar de las regiones montañosas al igual que de las porciones áridas y semiáridas de México (Rzedowski 1972, 1978, 1991a; Rzedowski y Calderón de Rzedowski 1989; Villaseñor 2003). Además de Asteraceae, Fabaceae y Poaceae, también es importante la presencia de otras ocho familias en el pastizal (Cactaceae, Convolvulaceae, Cyperaceae, Lamiaceae, Oxalidaceae, Polypodiaceae, Pteridaceae y Solanaceae). Estas once familias aportan 70% del total de las especies registradas, el 30% restante lo suministran 30 familias (Apéndice). Entre los géneros con mayor riqueza de especies, destacan *Solanum*, *Bouteloua*, *Salvia*, *Stevia*, *Ipomoea* y *Oxalis*. La relevancia de la familia Cactaceae y los géneros *Salvia* y *Stevia*, por su riqueza de especies, es un rasgo poco registrado en pastizales de otras partes del mundo.

Del total de las especies, solo 8% son introducidas, de éstas, cinco provienen de Europa, cuatro de África probablemente del sur del Sahara (Rzedowski y Calderón de Rzedowski 1990), una es de origen asiático-africano, una euro-asiática y una de origen desconocido. El 2% de las especies son naturalizadas, el 27% son endémicas de México y el 39% se comportan como malezas ruderales o arvenses, o son plantas invasoras, en las que su presencia se puede interpretar como indicadoras de disturbio, de sobrepastoreo, de vegetación secundaria y/o de erosión. A pesar de las especies introducidas, la flora nativa del pastizal es sustantiva pues representa más del 90% del total registrado (Cuadro 2, Apéndice).

Aspecto fisonómico-florístico y composición florística del pastizal

El pastizal está conformado por tres áreas bien definidas que, de acuerdo a su fisonomía y composición florística y atendiendo a los criterios de Shreve (1942), Leopold (1950) y Gentry (1957) se identificaron como pastizal-encinal, cacto-Acacia-pastizal y pastizal abierto.

1. *Pastizal-encinal*.—Esta asociación alberga especies características de clima templado como: *Adiantum poiretii*, *Astrolepis sinuata*, *Cheilanthes kaulfussii*, *Ch. lindheimeri*, *Pellaea cordifolia*, *Phlebodium areolatum*, *Polypodium thyssanolepis*, *Quercus castanea*, *Q. deserticola*, *Salvia mexicana* var. *mexicana* y *S. reptans*. Asimismo, habitan especies de gramíneas de gran porte tales como: *Aristida adscensionis*, *Bouteloua barbata* var. *barbata*, *B. hirsuta* var. *hirsuta*, *B. repens*, *Lycurus phleoides*, *Piptochaetium fimbriatum* y *Setaria parviflora*. Esta área muestra suaves pendientes y una pequeña barranca con gran cantidad de rocas que generan escurrimientos y pequeños cuerpos de agua durante la estación lluviosa. Estas condiciones facilitan la formación de microhábitats que albergan una riqueza notable de especies vegetales. Esta zona ocupa una cuarta parte del área estudiada. En años anteriores, posiblemente su extensión fue mayor, sin embargo, la tala inmoderada redujo el número de individuos de *Quercus* lo que originó una menor cantidad de microhábitats, indispensables para el establecimiento de otras especies.

2. *Cacto-Acacia-pastizal*.—Los componentes de esta asociación son gramíneas de talla corta que se extienden como césped entre las herbáceas. Estas gramíneas están asociadas con especies de *Opuntia* y *Mimosa* (espaciadas a gran distancia) y algunas otras herbáceas que crecen junto a ellas. Destacan por su presencia *Aristida adscencionis*, *Bouteloua hirsuta* var. *hirsuta*, *Bouteloua dactyloides*, *Hilaria cenchroides* y *Setaria parviflora*. Esta área tiene una pendiente suave con afloramiento de 10% de rocas, mismas que, por intemperismo físico han formado pequeñas hondonadas y fisuras de tamaño suficiente para almacenar agua o en su caso albergar algunas especies vegetales. Esta área tiene mayor extensión que el pastizal-encinal y equivale a 3/8 del total del área del pastizal. No obstante su extensión, su riqueza florística es menor por la escasez de microhábitats y posiblemente también por el uso y manejo más intensivo.

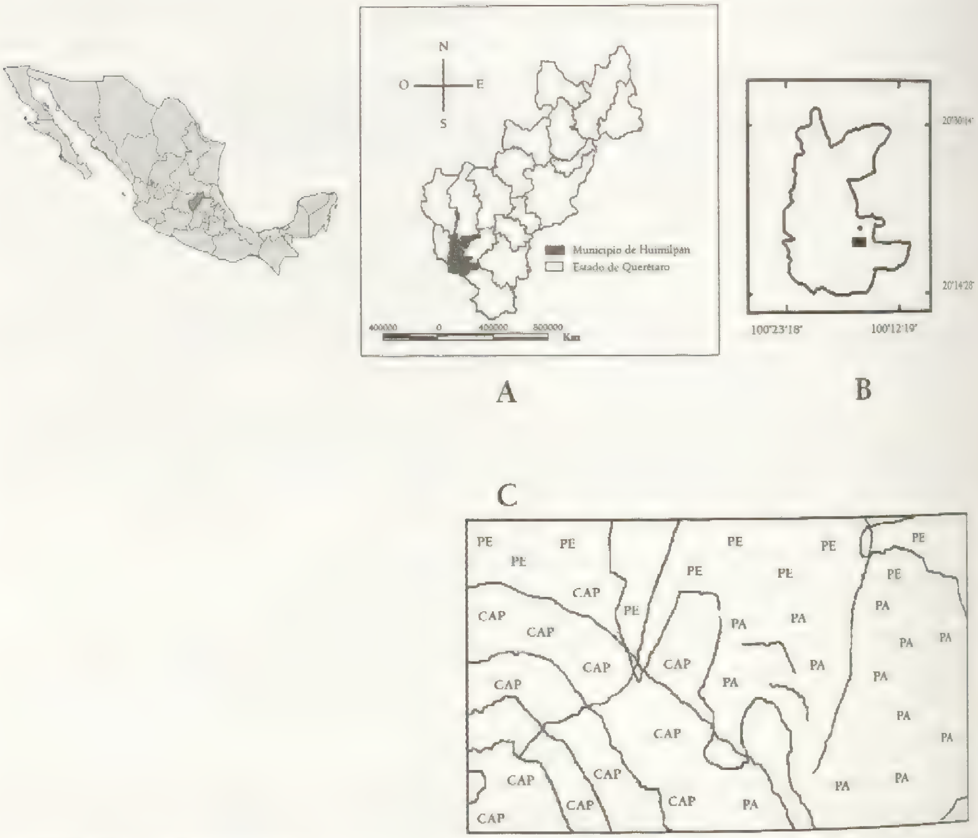

Fig. 1. Localización del estado de Querétaro. A. Estado de Querétaro con el municipio de Huimilpan sombreado. B. Municipio de Huimilpan mostrando su cabecera municipal en círculo y la ubicación del pastizal con un rectángulo. C. Forma y superficie del pastizal con la distribución de las tres asociaciones fisonómico-florísticas, PE = pastizal encinal, CAP = Cacto-*Acacia*-pastizal, PA = pastizal abierto.

3. *Pastizal abierto*.—Esta superficie alberga una vegetación pobre en la que los componentes son principalmente gramíneas de talla corta que se extienden como césped y los representantes de la familia Asteraceae son escasos. Las gramíneas más abundantes son: *Aristida adscensionis*, *Bouteloua barbata* var. *barbata*, *B. hirsuta* var. *hirsuta*, *Cynodon dactylon*, *Lycurus phleoides* y *Microchloa kunthii*. Los representantes de la familia Asteraceae son: *Erigeron janivultus*, *Perymenium buphthalmoides*, *Piqueria trinervia*, *Stevia serrata* y *Tagetes lucida*. Estas especies incrementan el número de individuos durante la estación lluviosa y emergen algunas especies bulbosas y rizomatosas de las familias Cyperaceae, Convolvulaceae y Oxalidaceae, entre otras, destacando *Bulbostylis funckii*, *Castilleja lithospermoides*, *Cyperus seslerioides*, *Desmodium grahamii*, *Eryngium carlinae*, *Evolvulus prostratus*, *Ipomoea capillacea*, *Oxalis corniculata*, *O. decaphylla*, *O. lunulata*, *Macroptilium gibbosifolium*, *Phytolacca icosandra* y *Zornia thymifolia*. La topografía y superficie de las áreas en las que se distribuye esta asociación son similares a las encontradas en la asociación cacto-*Acacia*-pastizal. Los microhábitats son escasos y están representados por las fisuras y hondonadas de las rocas.

En general, todo el pastizal muestra un estrato rasante de gramíneas cespitosas y plantas rastreras y un estrato herbáceo con gramíneas y especies de Asteraceae. Plantas leñosas como *Acacia farnesiana* var. *farnesiana*, *A. schaffneri* var. *schaffneri*, *Ipomoea murucoides*, *Mimosa aculeaticarpa* var. *biuncifera*, *Quercus castanea* y

Cuadro 1. Participación cuantitativa de especies vegetales por grupos taxonómicos en el pastizal.

Grupos	Familias	Géneros	Especies	Subspecies	Variedades
Pteridophyta	2	6	7	-	-
Magnoliophyta					
Liliopsida	7	29	38	1	2
Magnoliopsida	32	76	97	2	3
Total	41	111	142	3	8

Cuadro 2. Participación de la flora del pastizal según su origen.

Origen	Número de especies	Porcentaje de especies
Nativas	130	92
Indicadoras de disturbio	56	39
Endémicas	38	27
Introducidas	12	8
Naturalizadas	3	2

Q. desercticola, algunas epífitas como *Tillandsia recurvata* y trepadoras como *Cissus verticillata* son escasas o poco abundantes.

En este pastizal de origen secundario, además de la presencia de especies de Poaceae, Asteraceae y Fabaceae hay otros componentes importantes. *Bouchetia erecta*, *Solanum marginatum* y *S. rostratum* destacan entre las Solanaceae; *Salvia amarissima*, *S. mexicana* var. *mexicana* y *S. reptans* entre las Lamiaceae; *Coryphantha ottonis*, *Stenocactus dichroacanthus*, *Opuntia tomentosa*, *O. streptacantha* entre las Cactaceae; *Evolvulus alsinioides*, *E. prostratus*, *Ipomoea capillacea* entre las Convolvulaceae; *Oxalis corniculata*, *O. decaphylla* entre las Oxalidaceae y algunas pteridofitas xerófilas y/o mesofíticas como *Adiantum poiretii*, *Astrolepis sinuata*, *Cheilanthes lindheimeri*, *Pellaea cordifolia*, y *Phlebodium areolatum*.

En cualquier pastizal es importante la presencia de microhábitats para el establecimiento de las especies, especialmente de pteridofitas. En el estudiado, los microhábitats están representados por hondonadas, ranuras entre rocas y algunas asociaciones vegetales entre opuntias, mimosas, gramíneas, comelinas y asteráceas. Estos microambientes, por ser sitios inaccesibles al ganado, favorecen el desarrollo de gramíneas con mayor porte así como la riqueza florística.

El Pastizal-encinal es dos veces (43%) más rico que el Pastizal abierto y sobrepasa en riqueza al Cacto-*Acacia*-pastizal en un 17%. La riqueza florística se ve mermada en el pastizal abierto a pesar de tener, junto con el cacto-*Acacia*-pastizal, mayor extensión. Esta diferencia en composición florística se explica por la escasez de microhábitats, por la escasa presencia de arbustos y herbáceas y posiblemente por el manejo que se hace del área (pastoreo excesivo y no planeado).

En las tres zonas del pastizal habitan especies comunes entre sí y otras exclusivas a cada una. El pastizal encinal alberga una mayor riqueza de especies exclusivas, seguido por el cacto-*Acacia*-pastizal y el pastizal abierto. El cacto-*Acacia*-pastizal y el pastizal-encinal comparten 24% de las especies registradas en todo el pastizal y 18% de las especies son compartidas por las tres áreas.

A nivel de familia (Apéndice), ocho (Apocynaceae, Brassicaceae, Fabaceae, Amaranthaceae, Cistaceae, Crassulaceae, Fagaceae, Papaveraceae y Polypodiaceae) crecen de manera exclusiva en el Pastizal encinal. El Cacto-Acacia-pastizal alberga cinco familias exclusivas (Amaryllidaceae, Onagraceae, Plantaginaceae, Themidaceae y Viscaceae) y en el Pastizal abierto sólo dos familias son exclusivas (Malvaceae y Verbenaceae). Existe una clara correspondencia entre las riquezas florística y la riqueza de taxa exclusivos, el pastizal encinal es más rico y también tiene más taxa exclusivos. El resto de los taxa son compartidos por dos o las tres asociaciones del pastizal.

Cambios florísticos del pastizal y su estacionalidad

Las tres asociaciones del pastizal manifiestan cambios florísticos a través del año con el paso de las estaciones. *Aristida adscensionis, Lycurus phleoides* y *Microchloa kunthii* forman una carpeta vegetal continua a manera de césped durante la estación seca (otoño-invierno). No obstante, existe la presencia de otras gramíneas como *Bouteloua barbata* var. *barbata, B. hirsuta* var. *hirsuta, B. polymorpha* y *B. scorpiodes*, entre otras.

Durante la estación lluviosa (primavera-verano) es evidente un cambio en la composición específica de la carpeta vegetal rasante. La presencia de gramíneas se ve opacada por el desarrollo de numerosas plantas efímeras bulbosas y rizomatosas que provocan marcados cambios en la vegetación, durante un corto periodo de tiempo, después de la aparición de las lluvias. En este periodo destacan: *Erigeron janivultus, Evolvulus prostratus, Ipomoea capillacea, Macroptilium gibbosifolium, Milla biflora, Oxalis corniculata, O. decaphylla, O. lunulata, Zephyranthes sessilis* y *Zornia thymifolia*. Los elementos que constituyen este conjunto son más abundantes aún en espacios reducidos como las ranuras de rocas y pequeñas hondonadas o a la sombra de los encinos y de algunas herbáceas de mayor tamaño.

En el cacto-*Acacia*-pastizal y en el pastizal abierto se observan asociaciones características entre mimosas-compuestas-comelinas-gramíneas-opuntias, mimosas-comelinas, mimosas-asteráceas, opuntias-asteráceas-gramíneas, opuntias-asteráceas y opuntias-gramíneas. Al abrigo de de estas agrupaciones la riqueza florística es mayor.

Formas de vida

El pastizal concentra once de las formas de vida registradas para plantas vasculares. Las herbáceas contribuyen con poco más de la mitad de las especies (53%) y junto con los arbustos y las rizomatosas aportan casi el 85% de la flora del pastizal, mientras que, el 25% restante lo proporcionan las otras siete formas biológicas (Cuadro 3). Fabaceae (4), Solanaceae (4) Convolvulaceae (3), Poaceae (3) y Asteraceae (3) son las familias con mayor número de formas de vida. No hay una correspondencia entre la riqueza específica y la riqueza de formas de vida, pues Convolvulaceae con sólo cino especies reúne tres formas de vida (Apéndice).

Las especies herbáceas constituyen un porcentaje destacado de la flora del pastizal, lo que distingue, en general, a las floras de climas templados y semiáridos (Rzedowski y Calderón de Rzedowski 1989). Las plantas hemiparásitas son escasas, debido a la escasa presencia de árboles y arbustos además de que las aves, normalmente su agente de dispersión, tampoco abundan por el mismo efecto. Las plantas epífitas también son escasas, solamente en el pastizal-encinal se llega a establecer una especie por la humedad atmosférica que se conserva en el lugar.

Diversas especies de arbustos forman asociaciones que constituyen un microhábitat que favorece el crecimiento de otras herbáceas. Éstas últimas quedan protegidas de la desecación y del ramoneo por animales alcanzando mayor porte.

Análisis y comparación florística del pastizal estudiado con otros pastizales mexicanos

Por su aspecto fisonómico-florístico y las condiciones de aridez, este pastizal tiene una marcada similitud con el pastizal de *Bouteloua* y el cacto-*Acacia*-pastizal del estado de Durango (Gentry 1957) y los pastizales de *Hilaria cenchroides* y *Bouteloua dactyloides* del Valle de México (Cruz 1969). Los pastizales del estado de Durango tienen menor riqueza a nivel familiar, genérico y específico. Para el Valle de México, Cruz (1969) señala el pastizal de *Bouteloua dactyloides* con matorral de *Opuntia-Zaluzania-Mimosa* y bosque de *Quercus microphylla* con una riqueza taxonómica de 14 familias, 31 géneros y 35 especies, menor que la del pastizal de Querétaro. Solamente el pastizal de *Hilaria cenchroides* con Bosque de *Quercus centralis, Q. rugosa, Q. texcocana* y Matorral de *Opuntia streptacantha, Zaluzania-Mimosa aculeaticarpa* var. *biuncifera* superan al pastizal queretano en su riqueza (Cuadro 4).

Al comparar los taxa de este pastizal de Querétaro con los del pastizal de *Bouteloua* de Durango se tiene la coincidencia de 27(73%) familias, 43(46%) géneros y 17(13%) especies. El pastizal queretano comparte 14(58%) familias, 22(43%) géneros y 6(10%) especies con el Cacto-*Acacia*-pastizal de Durango. Con el pastizal de *Hilaria cenchroides* del Valle de México comparte 29(55%) familias, 53(41%) géneros y 37 (16%) especies.

Cuadro 3. Formas de vida presentes en la flora del pastizal.

Forma de vida	Número de especies	Porcentaje
Hierbas perennes	53	37
Arbustos	24	17
Hierbas anuales	23	16
Rizomatosas	20	14
Bulbosas	6	4
Trepadoras	5	3.5
Crasicaules	4	3
Árboles	3	2
Parásitas	2	1.4
Epífitas	1	0.7
Rastreras	1	0.7

Cuadro 4. Comparación por riqueza y superficie de la flora del pastizal de Querétaro con otros pastizales de México. Méx. = México, CAP = cacto-*Acacia*-pastizal, P = Pastizal, PA = pastizal abierto, PE = pastizal-encinal.

Región	Familias	Géneros	Especies	Superficie (Km^2)	Clima	Altitud (msnm)	Asociación	Referencia
Durango	37	94	134				P. de *Bouteloua*	Gentry (1957)
Durango	24	51	63				Cacto-*Acacia*-pastizal	Gentry (1957)
Valle de Méx.	53	130	233	380		2300-2700	P. de *Hilaria cenchroides*	Cruz (1969)
Valle de Méx.	14	31	35	140		2250-2400	P. *de Bouteloua dactyloides*	Cruz (1969)
Querétaro	42	111	142	3.33	$C(w_1)w$	1980-2460	CAP, PE, PA	Este trabajo

mientras que, con el pastizal de *Bouteloua dactyloides* del Valle de México comparte 10(71%) familias, 15(48%) géneros y 15(43%) especies.

Este pastizal queretano, a pesar de su reducida extensión, alberga una riqueza florística significativamente mayor a las registradas por Gentry (1957) y al pastizal de *Bouteloua dactyloides* descrito por Cruz (1969). El pastizal de *Hilaria cenchroides* del Valle de México, es el único que sobrepasa al pastizal estudiado, no obstante, la riqueza registrada para este pastizal de Querétaro es sustantiva si consideramos que la extensión de los otros pastizales sobrepasa en más de 100 veces la de éste último.

Atendiendo a los criterios de evolución de los pastizales (Johnston 1963; Burkart 1975; Rzedowski 1975; Moore 1982) y la información proporcionada por los lugareños se asume que el pastizal estudiado es de tipo secundario, producto de la intensa actividad antrópica mediante la ganadería no planeada y el empleo de fuego, factores que han ido seleccionando a las especies resistentes. Es posible que este sitio anteriormente haya sido un bosque templado de *Quercus*, no obstante, la tala inmoderada originó el establecimiento de herbáceas. Bajo estas condiciones las especies de Poaceae y Asteraceae se vieron favorecidas por su capacidad de adaptación a estos ambientes cambiantes. Así, se originaron áreas donde las herbáceas mezcladas con *Quercus* dieron paso al pastizal-encinal y algunas áreas totalmente abiertas formaron el pastizal abierto que poco a poco se fue repoblando de elementos característicos de matorral xerófilo y originándose así el cacto-*Acacia*-pastizal. Este tipo de repoblación, en pastizales, se reconoce como Dinámica de Fase de Anidamiento (Yeaton 1995).

Este pastizal está sometido al sobrepastoreo por ganado caprino, ovino y equino. *Aristida adscensionis, Bouteloua barbata* var. *barbata, Bouteloua dactyloides, Eragrostis mexicana* ssp. *virescens* y *Lycurus phleoides* son especies indicadoras. Este efecto propicia la invasión de plantas leñosas y herbáceas no palatables para el ganado y cambia la composición de la carpeta de gramíneas. Las especies más apetecidas y nutritivas como *Bouteloua repens, B. polymorpha, Cynodon dactylon, Digitaria ciliaris, Paspalum denticulatum, Schyzachyrium sanguineum* y *Setaria parviflora* son sustituidas por otras de menor valor forrajero como *Aristida adscensionis, Eragrostis mexicana, Microchloa kunthii, Muhlenbergia capillaris, Nassella mucronata* y *Piptochaetium fimbriatum*.

Este tipo de pastizal secundario es característico de la mitad septentrional del país, es más abundante del lado occidental que del oriental (Rzedowski 1978) y se ve favorecido por su clima fresco y la presencia de laderas inclinadas. No obstante y a pesar de que éste es un pastizal secundario que sustituyó una cubierta boscosa de *Quercus*, hasta ahora no es afectado por la invasión de especies como *Melinis repens* y *Eleusine multiflora*. Estas especies introducidas y de gran capacidad de establecimiento no representan aún un peligro que pudiera derivar en el desplazamiento de la flora nativa del pastizal.

CONSIDERACIONES FINALES

Este pastizal queretano registra una riqueza florística importante donde más del 90% de sus especies son nativas. No obstante, este pastizal comienza a mostrar algunos signos de deterioro provocados por el pastoreo excesivo y no planeado que se lleva a cabo en el área. También, la apertura reciente de áreas de recreo cercanas al pastizal (charcas temporales y permanentes y algunos bordos) están provocando pisoteo excesivo por el tránsito de personas además del tránsito permanente de vehículos, pues el pastizal es atravesado por un camino que conduce a la comunidad de Escolásticas, lugar donde se procesan piezas de cantera para la construcción.

A pesar de que el pastizal es de origen secundario representa un recurso importante para la región por las condiciones florísticas que alberga, así entonceses, será importante tomar medidas de ordenamiento y conservación dirigidas a preservar esta comunidad vegetal y sus especies. De no ser así, los factores de deterioro continuarán alterando el pastizal de tal manera que en un futuro la flora nativa podría ser remplazada por la invasión de especies exóticas y no deseables. Por otra parte, la destrucción o remplazo de las especies que contribuyen con la formación de microhábitats provocará una disminución gradual de la riqueza florística del pastizal y la cubierta vegetal irá disminuyendo hasta dejar la superficie expuesta al intemperismo, provocando una pérdida importante de la cubierta vegetal y de suelo.

APÉNDICE

Catálogo de las especies registradas en el pastizal con información sobre su origen y formas de vida. La presencia de la especie en cada asociación del pastizal se señala con PE = pastizal encinal, CAP = cacto-*Acacia*-pastizal, PA = pastizal abierto. Si la especie es introducida se señala entre paréntesis la procedencia: AA = Africa-Asia, Af = africa, EAs = Euroasiática, Eu = EuropeaEn cada especie se señala también cuando es indicadora de disturbio (d), de erosión (e), de sobrepastoreo(s) si es maleza (m), maleza arvense (ma), maleza ruderal (mr) o habita en vegetación secundaria (vs). Las formas de vida se señalan como A = árbol, AR = arbusto, B = bulbosa, C = crasicaule, E = epífita, HA = hierba anual, HP = hierba perenne, P = parásita, RA = rastrera, RI = rizomatosa, T = trrepadora.

PTERIDOPHYTA

POLYPODIACEAE

Phlebodium areolatum (Humb. & Bonpl. ex Willd.) J. Sm., Nativa, PE, RI
Polypodium thyssanolepis A. Braun. ex Klotzch, Nativa, PE, RI

PTERIDACEAE

Adiantum poiretii Wikstr., Nativa, PE, RI
Astrolepis sinuata (Lag. ex Sw.) D.M. Benham & Windham, Nativa, CAP-PE, RI
Cheilanthes kaulfussii Kunze, Nativa, PE, RI
Cheilanthes lindheimeri Hook., Nativa, PE, RI
Pellaea cordifolia (Sessé & Moc.) A. R. Sm., Nativa, PE, RI

LILIOPSIDA (Monocotyledoneae)

Amaryllidaceae

Zephyranthes sessilis Herb., Nativa, d, CAP, B

Anthericaceae

Echeandia flavescens (Schult. & Schult. f.) Cruden, Nativa, d, CAP-PE, HP
Echeandia nana (Baker) Cruden, Nativa, CAP-PE, HP

Bromeliaceae

Tillandsia recurvata L., Nativa, Endémica, CAP-PE, E

Commelinaceae

Commelina tuberosa L., Nativa, CAP-PE, HP

Cyperaceae

Bulbostylis funckii (Steud.) C. B. Clark, Nativa, s, PE-PA, HA
Carex humboldtiana Steud., Nativa, d, PE, HP
Cyperus seslerioides Kunth, Nativa, PA, RI
Karinia mexicana (C. B. Clarke ex Britton) Reznicek & McVaugh, Nativa, Endémica, CAP-PE-PA, B

Poaceae

Agrostis hyemalis (Walter) Britton, Sterns & Poggenb., Introducida (Eu), Naturalizada, PE-PA, HP
Aristida adscensionis L., Nativa, S, e, CAP-PE-PA, HA
Bouteloua barbata Lag. var. *barbata*, Nativa, Endémica, CAP-PE-PA, HA
Bouteloua dactyloides (Nutt) Columbus, Nativa, s, e, CAP, HA
Bouteloua hirsuta Lag. var. *hirsuta* Nativa, Endémica, CAP-PE-PA, HP
Bouteloua polymorpha (E. Fourn.) Columbus, Nativa, Endémica, PA, HP
Bouteloua repens (Kunth) Scribn., Nativa, Endémica, CAP-PE-PA, HP
Bouteloua scorpioides Lag., Nativa, Endémica, CAP-PA, HP
Chloris virgata Sw., Nativa, d, s, e, PE,HA
Cynodon dactylon (L.) Pers., Introducida (Eu), ma, mr, d, CAP-PE-PA, RI
Digitaria ciliaris (Retz.) Koeler, Nativa, d, CAP-PE-PA, HA
Eleusine multiflora Hochst. ex A. Rich., Introducida (Af), PE, HA
Eragrostis mexicana ssp. *virescens* (J. Presl.) S.D. Koch & Sánchez Vega, Nativa, d, mr, s, CAP-PE-PA, HA
Hilaria cenchroides Kunth, Nativa, s, CAP-PE-PA, HP
Lycurus phleoides Kunth, Nativa, s, d, CAP-PE-PA, RI

Melinis repens (Willd.) Zizka, Introducida (Af), vs, CAP, HP
Michrochloa kunthii Desv., Nativa, CAP-PE-PA, HP
Muhlenbergia capillaris (Lam.) Trin., Nativa, Endémica, CAP-PE, HP
Muhlenbergia implicata (Kunth) Trin., Nativa, Endémica, CAP-PE, HA
Nassella mucronata (Kunth) R. W. Pohl, Nativa, PE, HP
Panicum hallii Vasey, Nativa, CAP, HP
Paspalum denticulatum Trin. Nativa, CAP-PE, HP
Paspalum notatum Alain ex Flûggé, Nativa, d, CAP-PE-PA, HP
Piptochaetium fimbriatum (Kunth) Hitchc., Nativa, PE-PA, HP
Schyzachyrium cirratum (Hack.) Wooton & Standl., Nativa, CAP-PE, RI
Schyzachyrium sanguineum (Retz.) Alston, Nativa, CAP,HP
Setaria parviflora (poir.) Kerguélen, Nativa, PE-PA,RI
Sporobolus indicus (L.) R. Br., Nativa, CAP-PE ,HP

Themidaceae
Milla biflora Cav., Nativa, mr, vs, CAP, B

MAGNOLIOPSIDA (Dicotyledoneae)

Acanthaceae
Ruellia nudiflora (Engelm. & A. Gray) Urb., Nativa, Endémica, PE, HP
Stenandrium dulce (Cav.) Ness, Nativa, CAP-PE, RI

Amaranthaceae
Dysphania ambrosioides (L.) Mosyakin & Clemants, Nativa, ma, mr, PE,HP
Gomphrena serrata L., Nativa, m, vs, CAP-PE,HP

Apiaceae
Eryngium carlinae F. Delaroche, Nativa, Endémica, CAP-PE-PA, HP

Apocynaceae
Asclepias linaria Cav., Nativa, d, CAP-PE, AR
Mandevilla foliosa (Mull. Arg) Hemsl., Nativa, Endémica, PE, AR

Asteraceae
Ageratina petiolaris (Moc. & Sessé ex DC.) R. M. King & H. Rob., Nativa, Endémica, d, CAP, AR
Barkleyanthus salicifolius (Kunth) H. Rob & Brettel, Nativa, Endémica, d, CAP-PE, AR
Brickellia tomentella A. Gray, Nativa, CAP, AR
Cosmos bipinnatus Cav., Nativa, ma, mr, PE, HA
Dyssodia papposa (Vent.) Hitchc., Nativa, d, ma, mr, PE, HA
Erigeron janivultus G. L. Nesom, Nativa, CAP-PA, HP
Fleischmannia pycnocephala (Less.) R. M. King & H. Rob., Nativa, Endémica, vs, CAP-PE, HP
Heterosperma pinnatum Cav., Nativa, d, CAP-PE, HA
Laennecia sophiifolia (Kunth) G. L. Nesom, Nativa, ma, mr, vs, CAP, HA
Perymenium buphthalmoides DC., Nativa, Endémica, PE-PA, HP
Pinaropappus roseus (Less.) Less., Nativa, mr, vs, PE, HP
Piqueria trinervia Cav., Nativa, CAP-PE-PA, HP
Pseudognaphalium stramineum (Kunth) Anderb., Nativa, d, ma, mr, PE, HA
Psilactis brevilingulata Sch. Bip. ex Hemsl., Nativa, ma, mr, PE, HA
Roldana heracleifolia (Hemsl.) H. Rob & Brettel, Nativa, Endémica, CAP-PE, HP
Schkuhria pinnata (Lam.) Kuntza ex Thell. Nativa, d, ma, mr, CAP, HA
Stevia pilosa Lag. Nativa, Endémica, CAP, HP
Stevia serrata Cav., Nativa, Endémica, VS, PE-PA, RI
Stevia tephra B. L. Rob., Nativa, Endémica, PE, HP
Tagetes lúcida Cav., Nativa, Endémica, d, vs, PA, RI
Tagetes lunulata Ortega, Nativa, Endémica, d, mr, CAP, HA
Xanthocephalum centauroides Willd., Nativa, PE, HP
Zaluzania augusta (Lag.) Sch. Bip., Nativa, CAP-PE, AR

Brassicaceae
Eruca sativa Mill., Introducida (Eu), Naturalizada, ma, mr, PE, HA
Lepidium latifolium L., Introducida (Eu), PE, HP

Cactaceae
Coryphantha ottonis (Pfeiff.) Lem., Nativa, CAP-PA, C
Stenocactus dichroacanthus (Mart. ex Pfeiff.) A. Berger ex Backeb & F. M. Knuth, Nativa, CAP, C
Opuntia streptacantha Lem., Nativa,Endémica, CAP-PE-PA, C
Opuntia tomentosa Salm-Dyck, Nativa, CAP-PE, C

Cistaceae
Helianthemum glomeratum (Lag.) Lag. ex DC., Nativa, d, vs, PE, HP

Convolvulaceae
Evolvulus alsinoides L., Nativa, m, CAP-PEHP
Evolvulus prostrates B. L. Rob., Nativa, CAP-PE-PA, RA
Ipomoea capillacea (Kunth) G. Don, Nativa, Endémica, vs, CAP-PE-PA, HP
Ipomoea murucoides Roem. & Schult., Nativa, Endémica, CAP, A
Ipomoea purpurea (L.) Roth, Nativa, ma, mr, PE, T

Crassulaceae
Echeveria secunda Booth ex Lindl., Nativa, PE, HP

Euphorbiaceae
Croton cilicatoglandulifer Ortega, Nativa, Endémica, CAP-PE, AR
Ricinus communis L., Introducida (Af), CAP-PE, AR

Fabaceae
Acacia farnesiana (L.) Willd. var. *farnesiana*, Nativa, Endémica, m, vs, CAP, AR
Acacia schaffneri (S. Watson) F. J. Herm. var. *schaffneri*, Nativa, Endémica, PE, AR
Brongniartia intermedia Moric., Nativa, PE, AR
Brongniartia magnibracteata Schltdl., Nativa, PE, AR
Calliandra humilis var. *reticulata* (A. Gray) L. D. Benson, Nativa, PE, HP
Cologania angustifolia Kunth, Nativa, PE, T
Dalea foliolosa (Aiton) Barneby var. *foliolosa*, Nativa, PA, HA
Desmodium grahamii A. Gray, Nativa, Endémica, PA, HA
Havardia pallens (Benth.) Britton & Rose, Nativa, PE, AR
Nissolia microptera Poir., Nativa, PE, T
Macroptilium gibbosifolium (Ortega) A. Delgado, Nativa, CAP-PE-PA, HP
Mimosa aculeaticarpa var. *biuncifera* (Benth.) Barneby, Nativa, CAP-PE, AR
Senna septemtrionalis (Viv.) H. S. lewin & Barneby, Nativa, vs, PE, AR
Zornia thymifolia Kunth, Nativa, CAP-PE-PA, HP

Fagaceae
Quercus castanea Née, Nativa, Endémica, PE, A
Quercus deserticola Trel., Nativa, Endémica, PE, A

Lamiaceae
Salvia amarissima Ortega, Nativa, Endémica, d, PA, HP
Salvia mexicana L. var. *mexicana*, Nativa, Endémica, d, CAP-PE, HP
Salvia reptans Jacq., Nativa, Endêmica, PE, HP

Loranthaceae
Psittacanthus calyculatus (DC.) G. Don, Nativa, CAP-PE, AR

Lythraceae
Cuphea aequipetala Cav., Nativa, CAP-PE, HP
Heimia salicifolia Link., Nativa, CAP-PE, AR

Malvaceae
Sida linearis Cav., Nativa, PA, HP

Oleaceae
Forestiera phillyreoides (Benth.) Torr., Nativa, CAP-PE, AR

Onagraceae
Gaura hexandra Ortega ssp. *hexandra*, Nativa, CAP, HP

Orobanchaceae
Castilleja lithospermoides Kunth, Nativa, Endémica, CAP-PA, HP

Oxalidaceae
Oxalis corniculata L., Introducida (Eu), ma, mr, vs, PE-PA, RI
Oxalis decaphylla Kunth, Introducida (AA), CAP-PE-PA, B
Oxalis lunulata Zucc., Nativa, CAP-PE-PA, B

Papaveraceae
Argemone mexicana L., Nativa, m, PE, HA

Phytolaccaceae
Phytolacca icosandra L., Nativa, d, m, CAP-PE-PA, HP

Plantaginaceae
Plantago nívea Kunth, Nativa, CAP, HP

Polemoniaceae
Loeselia coerulea (Cav.) G. Don, Nativa, d, CAP-PE, HP
Loeselia mexicana (Lam.) Brand, Nativa, d, vs, PE, AR

Rhamnaceae
Condalia velutina I. M. Johnst., Nativa, CAP-PE, AR
Karwinskia humboldtiana (Roem. & Schult.) Zucc., Nativa, Endémica, vs, CAP-PE, AR

Rubiaceae
Bouvardia ternifolia (Cav.) Schltdl., Nativa, Endémica, d, CAP-PE, AR
Richardia tricocca ssp. *tetracocca* (M. Martens & Galeotti) W. H. Lewis & R. L. Oliver, Nativa, PA, HP

Scrophulariaceae
Buddleja perfoliata Kunth, Nativa, CAP, AR
Buddleja sessiliflora Kunth, Nativa, d, mr, CAP-PE-PA, AR

Solanaceae
Bouchetia erecta DC. ex Dunal, Nativa, Endémica, d, CAP-PE-PA, HP
Datura stramonium L., Nativa, ma, mr, PE, HP
Nicotiana glauca Graham, Nativa, mr, CAP,AR
Solanum americanum Mill, Nativa, PE, HP
Solanum dulcamaroides Dunal, Introducida (EAs), PA, T
Solanum marginatum L. f., Introducida (Af), Naturalizada, mr, vs, PE, AR
Solanum nigrescens M. Martens & Galeotti, Nativa, ma, mr, vs, CAP, HA
Solanum polyadenium Greenm., Nativa, PE, HA
Solanum rostratum Dunal, Introducida (?), d, ma, mr, vs, CAP-PE-PA, HA

Verbenaceae
Verbena canescens Kunth, Nativa, PA, HP

Viscaceae
Phoradendron brachystachyum (DC.) Nutt., Nativa, CAP, AR

Vitaceae
Cissus verticillata (L.) Nicolson & C.E. Jarvis, Nativa, CAP-PE, T

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BOOK REVIEW (CONTINUED)

Ashok Gadgil, Lawrence Berkeley, and Diana M. Liverman (eds.). 2010. **Annual Review of Environment and Resources, Volume 35, 2010.** (ISBN-13: 978-0-8243-2335-6, hbk.). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 1-800-523-8635, 1-650-493-4400). $80.00, 389 pp., 7 ⅝" × 9 ⅜".

(Review continued from page 706)

In section two, Benjamin Sovacool and Marilyn Brown discuss energy security and the vulnerability of industrialized nations as they adjust to the challenges of climate change. The authors argue that a nation's resilience to these changes is dependent upon four components: "availability, affordability, efficiency, and environmental stewardship." They use these components to develop an "Energy Security Index" and test it on 22 OECD member countries with the results indicating a great disparity between the highest performers and those with weak or deteriorating energy security. Author, Karl Zimmerer, offers a discussion of how "land use, climate change, and social-environmental shifts" affect the vulnerability, resilience, and adaptation of biological diversity in agriculture. He develops a framework using "four conceptual nodes" to achieve a greater understanding of biological diversity in agriculture across local, national, and international levels. Karen Seto and colleagues examine the relationship between urbanization and the environment offering insight on the historic adaptations and contemporary rescaling of urban environments to meet the needs of changing demographics and economic development worldwide. The authors maintain that rapid urbanization can lead to sustainability due to the forces of "agglomeration, increased innovation, and increased wealth" and conclude by laying out the challenge of changing the "scale, form, and rate" of urban growth to foster opportunities for sustainability.

In section three, Liliana Andonova and Ronald Mitchell address issues of rescaling environmental politics. They argue that in our increasingly connected world, environmental politics and governance are being rescaled vertically—downwards to local and provincial governments and upwards to "supranational" entities such as international NGOs and multi/transnationals. They are also being rescaled horizontally across regional and sectoral organizations as well as across disciplines such as trade and security. These shifts reflect changes in the "magnitude, complexity, and interconnectedness" of global environmental problems. Author, J.R. McNeill, concludes the *Review* with a retrospective piece on the field of environmental history. His article offers environmental history lessons from around the world that provide glimpses into the vulnerability and resilience of natural systems and the adaptability of both human and natural ecosystems. His piece offers food for thought on opportunities to revise and rescale our approach to our relationship with the natural world.

Each author offers an excellent abstract of their article to orient readers as well as summary points and the identification of future research needs at the end. The *Review*, however, is not a book to be kept on one's nightstand as it takes focus and concentration, even for someone with a scientific background. Ultimately, I found the *Review* to be extremely informative. Many of the articles offer intriguing insights on exciting fields of research for exploring the interconnectedness of human behavior and environmental degradation.—*Gwen Michele Thomas, Texas Master Naturalist & BRIT Volunteer, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

ALFAROA HONDURENSIS (JUGLANDACEAE) NUEVO GÉNERO Y NUEVA ESPECIE PARA EL SALVADOR Y UNA EXTENSIÓN SIGNIFICATIVA DE LA DISTRIBUCIÓN GEOGRÁFICA Y DE LA VARIACIÓN TOPOGRÁFICA DE UNA ESPECIE VULNERABLE

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RESUMEN

Alfaroa hondurensis L.O. Williams (Juglandaceae), actualmente listada como especie amenazada y vulnerable y se registra por primera vez para El Salvador. Anteriormente se creía que era endémica de Honduras. Se provee una descripcion detallada de la especie, de su fenología y del hábitat en El Parque Nacional Montecristo. El hallazgo de un nuevo género tiende a apoyar la conservación permanente de la region de bosque nebuloso en El Salvador, así como la exploración en los bosques contiguos en Honduras y Guatemala para lograr un mejor entendimiento de la amplitud de variación geográfica y topográfica de esta especie.

Palabras Clave: *Alfaroa*, bosque nebuloso, El Salvador, Parque Nacional Montecristo, Trifinio

ABSTRACT

Alfaroa hondurensis L.O. Williams (Juglandaceae), currently listed as a threatened and vulnerable species, is recorded for the first time en El Salvador. Previously thought endemic only to Honduras, a detailed description of the species, its phenology and the habitat where it found in El Parque Nacional Montecristo are provided. The finding of a new genus lends support to the continued conservation of the cloud forest region in El Salvador as well as further exploration into the contiguous cloud forest in Honduras as well as Guatemala to better understand the geographic range and ecology of this threatened species.

Key Words: *Alfaroa*, cloud forest, El Salvador, Montecristo National Park, Trifinio

INTRODUCCIÓN

El Parque Nacional Montecristo, el cual forma parte del área Trifinio, alberga una porción relativamente poco explorada y botánicamente muy rica, de uno de los bosques nebulosos mejor conservados de la parte norte de Centroamérica, extendiéndose hasta las vecinas Guatemala y Honduras. Como una de las más importantes áreas protegidas de El Salvador, ha servido como un centro para la investigación biológica desde su concepción. No obstante, debido a la falta de fácil acceso en algunas áreas de la región de bosque nebuloso del parque y la dificultad de obtención de permisos, los árboles de las regiones más altas del parque están relativamente inexplorados.

De febrero a abril de 2010, la primera autora condujo un estudio en El Parque Nacional Montecristo, que incluyó en la medición de todos los árboles en 24 parcelas de muestreo de 20 × 20 m cada 500 m en un muestreo aleatoriamente estratificado en la porción de bosque nebuloso del parque. Entre las plantas encontradas estaba *Alfaroa hondurensis*. Esta planta se conocía anteriormente sólo de Honduras y es listada como endémica de ese país (Nelson 1998 In IUCN 2010; Nelson 2001[2002]). El hallazgo de este género es el primer registro para El Salvador y expande significativamente la distribución geográfica conocida hasta ahora de esta especie (Fig. 2). Debido a que ha sido incluida en el listado de plantas en peligro (Nelson 1998 in IUCN 2010), así como a las pocas colectas anteriores y al conocimiento relativamente escaso de esta especie (Williams in Mannings 1959; Oldfield et al. 1998; Walter & Gillett 1998), este hallazgo es un hecho crucial para su conservación a largo plazo.

DESCRIPCIÓN DE LA ESPECIE

Alfaroa hondurensis L.O. Williams, Bull. Torrey Bot. Club 86:194. 1959. (**Figs. 1–3**). TYPE HONDURAS. DEPT. SANTA BARBARA: tree 80 ft tall, wood pink; road to Mochito Mine, vicinity of El Sauce near Lake Yojoa, alt. 1200 m, 26 Sep 1952, *Paul H. Allen and Alphonse Chable* 6573 (HOLOTIPO: US!).

A continuación se redescribe la especie e se ilustra como se encuentra en El Salvador.

Árbol de casi 25 m de alto; corteza externa parda o pardo rojiza, de apariencia rugosa, áspera y granulada al tacto, lisa en árboles viejos y desprendiéndose en placas irregulares, dejando manchas más claras que la corteza circundante, ca. 10 mm de grosor; madera rosada al corte; ramas ascendentes a horizontales, lenticeladas, las lenticelas ovales a alargadas más oscuras que la corteza circundante, glabras, pero posiblemente con escamas lepidotas cuando jóvenes; ápices de las ramitas y pecíolos a veces con exudados cerosos entremezclados con manchas resinosas. Hojas jóvenes cubiertas con exudados resinosos. Hojas 30 cm de largo, opuestas a subopuestas, decusadas, paripinnadas, folíolos en pares iguales o casi iguales; pecíolos 4–4.5 cm de largo, engrosados en el punto de unión con las ramitas, raquis de casi 10 cm de largo, glabros o con exudados cerosos, tornándose nítidos con la edad; folíolos 6–8 pares, raramente en números impares por supresión de uno de los dos folíolos terminales, alternos o usualmente subopuestos, elípticos a oblongo-lanceolados, agudos o acuminados, glabros en el haz y con numerosas escamas diminutas en el envés, 11–16 cm de largo y 3.8–5 cm de ancho, el envés mucho más pálido que el haz; peciólulos 2–4 mm largo, engrosados en la base. Inflorescencias y flores desconocidas. Fruto oblongo-ovoide, redondeado a ligeramente comprimido en corte transversal, glabro, café oscuro, cubierto con numerosas lenticelas pequeñas pero conspicuamente postulados sin crestas o muy ligeramente crestado longitudinalmente, de casi 6.5 cm de largo y 2.5–3 cm de diámetro; estigma persistente; endocarpo con paredes engrosadas y muy duras, 4–5 mm de grueso en la parte media; ovario 8-locular.

DISTRIBUCIÓN Y ECOLOGÍA

No se encontraron plantas maduras; no obstante, se localizaron múltiples individuos juveniles (aprox. 4 en sola una de las 24 parcelas). La localización de la parcela del hallazgo fue en: UTM (Universal Transverse Mercator) 0245725, 1594791 (Fig. 2), la elevación en la localidad del hallazgo es de 2180 msnm (con un error de ± 6 m), ampliando así la amplitud de variación topográfica conocida. Todos los juveniles fueron encontrados en un azimut de 160 grados y una pendiente de 4 a 10 grados en un bosque de crecimiento maduro, definido como mayor de 100 años sin perturbaciones a gran escala. Tanto los disturbios naturales como los humanos fueron tomados en consideración por medio de encuestas a los habitantes más viejos de la comunidad, acerca de la historia del uso del suelo en cada parcela.

Además de algunos casos de herbivoría ocasionada por insectos, no se encontró ninguna otra perturbación. No se detectaron señales de pastoreo o presencia de ganado, tampoco hubo erosión aparente dentro de la parcela ni evidencia de tala de árboles. Aunque se encontró un árbol grande y viejo caído cerca del centro de la parcela, que parecía haber sucedido caído al menos hace tres años (basándose en el nivel de regeneración observado), no se consideró esto como una perturbación a gran escala. El dosel a 2 m de altura arriba del piso del bosque desde el centro de la parcela, adyacente a *Alfaroa hondurensis* fue estimado en un 80%. La cobertura del suelo fue estimada en una 30% hojarasca, 65% materia herbácea y 5% de suelo.

Las especies encontradas en las proximidades de *Alfaroa hondurensis* son las siguientes: *Quercus bumelioides* Liebm., *Meliosma dentata* (Liebm.) Urban, *Persea americana* var. *nubigena* (L.O. Williams) L.E. Kopp. *Symplocos culminicola* Standl. & Steyerm, *Symplococarpon purpusii* (Brandegee) Kobuski, *Cinnamomum triplinerve* (Ruiz & Pav.) Kosterm., *Matudaea trinervia* Lundell, *Rondeletia rufescens* B.L. Rob., *Parathesis vulgata* Lundell, *Saurauia oreophila* Hemsl., *Quetzalia reynae* Lundell, *Weinmannia balbisiana* Kunth, *Eugenia liesneri* Barrie. Adicionalmente, muchas plantas juveniles de *Ocotea subalata* Lundell (nuevo registro para El Salvador) y *Podocarpus oleifolius* D. Don ex Lamb., fueron encontradas alrededor del sitio; ambas especies son consideradas raras en este tipo de bosque.

Las muestras de suelos fueron tomadas a una profundidad de 25 cm con un diámetro de 2.5 cm en una porción representativa de la parcela, dentro de los 5 m que rodeaban el centro de la parcela. El análisis de

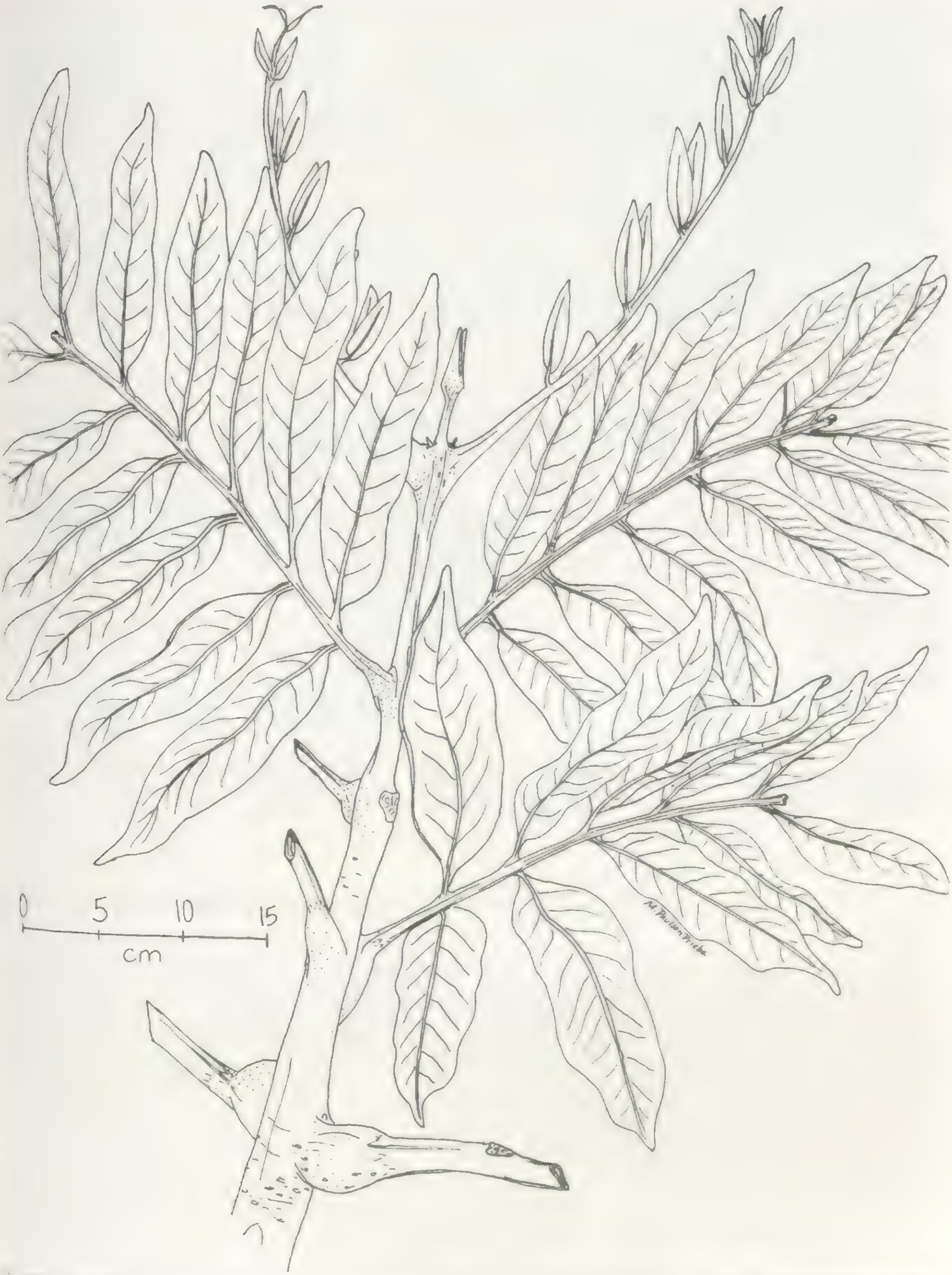

Fig. 1. Ramita de *Alfaroa hondurensis* con las hojas y crecimiento apical.

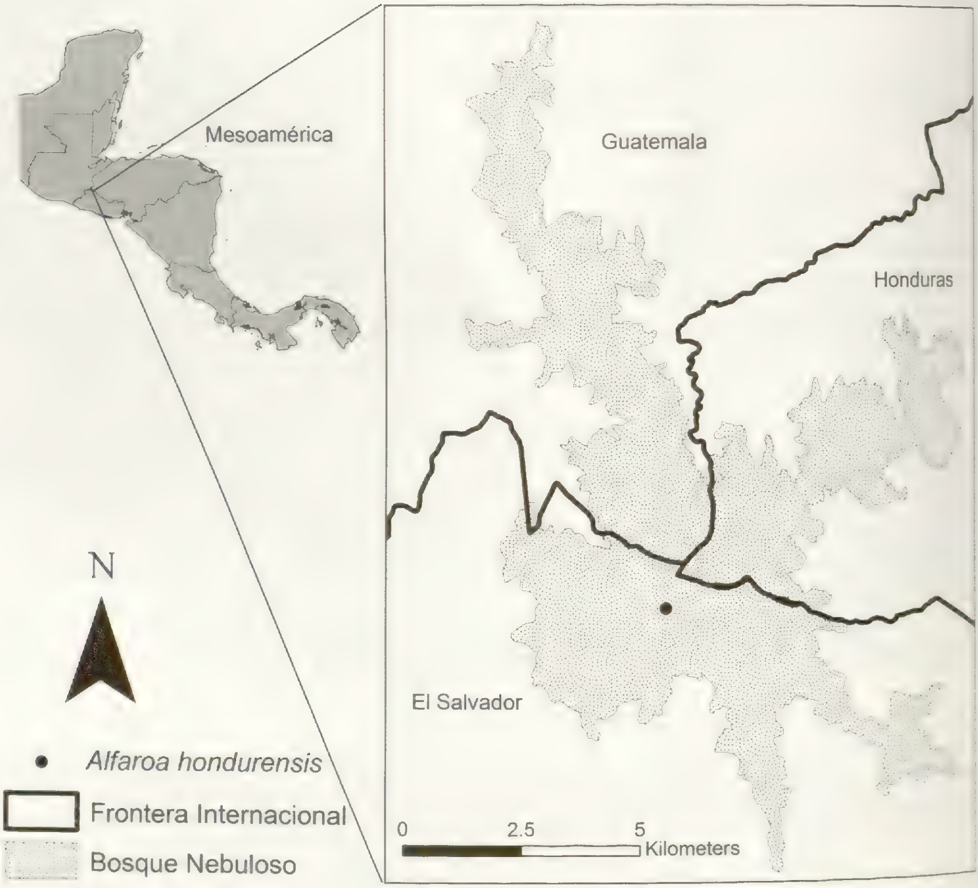

FIG. 2. Mapa con la nueva localidad de *Alfaroa hondurensis*, mostrando el área de bosque nebuloso que comparten Guatemala, El Salvador y Honduras.

campo de los suelos fue rudimentario y no se hizo un examen de laboratorio. No obstante, el horizonte O del suelo era relativamente más profundo que en las parcelas adyacentes, con una profundidad de 8.1 cm. El horizonte A abarca la porción restante de la muestra (16.5 cm) con algo de pérdida de suelo del fondo debido a la naturaleza no compactada del suelo. La composición del suelo era franco limo arcilloso con la siguiente composición: 25–40 % arcilla; 60–75 limo y 0–20% arena con un tono de 5YR, valor 3 e intensidad (chroma) de 1%.

Debido a que *Alfaroa hondurensis* está listada como una especie vulnerable, definida como en alto riesgo de extinción en el mediano plazo debido al área estimada de presencia de la especie, pocas áreas conocidas de existencia y la continua declinación en el área, calidad de hábitat número de localidades o subpoblaciones y la escasez de individuos maduros (Nelson 1998). Este nuevo hallazgo de *A. hondurensis* es de suma importancia para su conservación: amplía el área de distribución geográfica y la variación topográfica no solo de la especie sino del género, el cual nunca había sido registrado en El Salvador. Adicionalmente el bosque en el cual fue encontrada no está contiguo al bosque de donde se conocía previamente en la montaña de Celaque en Honduras. Por consiguiente, esta puede ser otra subpoblación. Afortunadamente, esta especie fue encontrada en un área que ya está protegida. La alta probabilidad de la ocurrencia de esta especie en los contiguos bosques nublosos de Honduras sugiere que hay una necesidad urgente de buscar y monitorear esta planta en el lado hondureño y guatemalteco del bosque nebuloso. Ya que el lado hondureño está naturalmente protegido por la

Fig. 3. Rama de *Alfaroa honderensis*, composición de hojas y crecimiento nuevo.

escabrosa topografía. Este hallazgo contribuye a apoyar el nivel de protección y la necesidad de llevar a cabo mayor investigación en el Parque Nacional Montecristo.

AGRADECIMIENTOS

Agradecemos grandemente a las autoridades de El Parque Nacional Montecristo por la oportunidad de conducir esta investigación, así como a los guardarrecursos y a los líderes de la comunidad de Majaditas que sirvieron de guías y/o asesores. Cosme Damián Reyes, Gregory Priebe, Gloria Noemy López Guerra y Reynaldo Eleximo Martínez López brindaron generosamente una asistencia crucial y entusiasta a esta investigación. Agradecemos a Frank Sullyvan Cardoza, por ser el fotógrafo de *Alfaroa* y por su asistencia en el campo. Adicionalmente, este trabajo de campo estuvo apoyado incansablemente por el duro trabajo y la atinada asesoría de Mark Paulson. El trabajo de campo que condujo a este descubrimiento fue patrocinado por National Science Foundation (numero 0926985), Indiana University Sustainability Grant y una generosa donación de Lloyd y Beverly Paulson. Agradecemos Fernando Chiang Cabrera y a dos revisores anónimos por sus sugerencias para mejorar este artículo.

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MICONIA PYRAMIDALIS (MELASTOMATACEAE: MICONIEAE): REPORTED FOR THE FIRST TIME FROM JAMAICA

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ABSTRACT

Miconia pyramidalis is reported for the first time for the flora of Jamaica. The species is largely restricted to the Greater Antilles and is much less common in Jamaica than the closely related and more broadly distributed *M. laevigata*.

RESUMEN

Se reporta por primera vez *Miconia pyramidalis* para la flora de Jamaica. Esta especie se encuentra restringida principalmente a las Antillas Mayores y es menos común en Jamaica que *M. laevigata*, una especie cercanamente relacionada a *M. pyramidalis* y ampliamente distribuida.

Miconia pyramidalis (Desr.) DC. is reported for the first time from Jamaica, where it occurs in the Blue Mountains (St. Andrew, St. Thomas and Portland Parishes) in disturbed moist montane forests, dry southern-slope forests, and thickets from 450–1250 m. The species is also known from Cuba, Hispaniola, and Puerto Rico, so its occurrence in Jamaica is not unexpected. It is much less common in Jamaica than the closely related and well-collected *M. laevigata* with which it is often confused. The latter is widely distributed in the Neotropics, occurring in Mexico, Central America, South America, and the Antilles. *Miconia pyramidalis*, in contrast, is largely restricted to the Greater Antilles, although it is of interest that the type (see Howard 1989) was collected in Guadeloupe (in the Lesser Antilles).

Miconia pyramidalis has been included within the circumscription of *M. laevigata* in most floristic treatments (e.g., Cogniaux 1891; Fawcett & Rendle 1926; León & Alain 1957; Liogier 1995, 2000; Proctor 1972). However, *M. pyramidalis* is readily distinguished from *M. laevigata* based on the evidence presented by Judd and Kabat (2005), thus we consider them to be specifically distinct. The two species were also distinguished by Moscoso (1943). *Miconia pyramidalis* is most easily differentiated from *M. laevigata* by its inflorescence architecture. In *M. pyramidalis* the inflorescences are more or less pyramidal, with the lower secondary branches elongated and possessing numerous internodes. These branches are frequently more or less indeterminate and culminate in a dense cluster of flower buds, which often abort. The ultimate inflorescence branches frequently bear 3-flowered units. In contrast, in *M. laevigata*, secondary inflorescence branches mostly consist of only one or two internodes, i.e., the branch meristem almost immediately produces a terminal flower. However, the basal branch-pair of an inflorescence may have more numerous internodes, repeating the pattern of the primary axis. Thus, the production of additional flowers results almost entirely from the development of one or more pairs of scorpioid-secund floral clusters, which develop through one-sided sympodial branching (see Fig. 3 in Judd & Kabat 2005). In *M. pyramidalis* the adaxial leaf surface dries much darker than the abaxial leaf surface (the adaxial leaf surface of *M. laevigata* dries only slightly darker), and the fruits are distinctly larger (to ca. 6 mm, vs. to ca. 4 mm in *M. laevigata*; pers. obs.). See Judd and Kabat (2005) for additional differentiating morphological characters.

The recognition of *Miconia pyramidalis* in Jamaica increases the number of species of *Miconia* (as traditionally circumscribed) documented for the island to 25 (see Proctor 1972).

The specimens cited below comprise our recent collections in Jamaica and the results of a survey of specimens at the Institute of Jamaica and in the herbarium of the University of the West Indies, Mona. In addition

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to the localities cited below, we observed *Miconia pyramidalis* growing just below Abbey Green (St. Thomas Parish), at ca. 1200 m. In Jamaica, *Miconia pyramidalis* was observed growing with or in close proximity to the following species of Melastomataceae: *Blakea trinerva* L., *Clidemia crossosepala* Griseb., *C. erythropogon* DC., *C. hirta* (L.) D. Don, *C. umbellata* (Mill.) Judd & Skean, *Mecranium virgatum* (Sw.) Triana, *Miconia albicans* (Sw.) Triana, *M. impetiolaris* (Sw.) DC., *M. laevigata* (L.) DC., *M. prasina* (Sw.) DC., *M. quadrangularis* (Sw.) Naud., *M. theaezans* (Bonpl.) Cogn., and *Ossaea hirsuta* (Sw.) Triana.

Voucher specimens: **JAMAICA. Portland Parish:** section to Greenhills, 3300 ft, 31 Mar 1963, *Adams 12,373* (UCWI); Blue Mountains, Wakefield (town ca. 1 mi S of Spring Hill on rd. to Hardwar Gap), 450 m, 24 May 1987, *Judd 5466* (FLAS, IJ); ridge SW of Haycock Mt., above Balcarres, 2000–2750 ft, 11 Jun 1953, *Proctor 8064* (IJ). **St. Andrew Parish:** Blue Mountains, Clydesdale, 3500 ft, 24–31 Aug 1943, *Barry s.n.* (IJ). **St. Thomas Parish:** along trail between Farm Hill and Abbey Green, 4000 ft, 29 Jul 1946, *Barry s.n.* (IJ); Blue Mountains, W of Whitfield Hall, on road to Penlyne Castle, lat. N18°02'43.2" and long, W76°37'35.4," 1195 m (by GPS), 1175 m (altimeter), 18 Jan 2011, *Judd 8322* (FLAS, IJ, NY); vicinity of Whitfield Hall, ca. 4100 ft, 2 Jun 1954, *Proctor 8731* (FLAS, IJ).

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MICONIA PSEUDORIGIDA (MELASTOMATACEAE: MICONIEAE) RE-COLLECTED IN THE JOHN CROW MOUNTAINS, JAMAICA, WITH NOTES ON ITS CONSERVATION STATUS

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ABSTRACT

Miconia pseudorigida, a rare and endangered species that has previously been collected only four times, was recently located and re-collected in the John Crow Mountains, about two miles southwest of Ecclesdown. On the basis of field observations, photographs and herbarium specimens, we update published accounts of its morphological variation and conservation status. Most noteworthy, the species consistently has intensely rose-red abaxial leaf surfaces on the new growth, a feature not previously known and useful in distinguishing *M. pseudorigida* from the related *M. rigida*. Additionally, the color of the supranodal glandular hairs is reported for the first time.

Key Words: Melastomataceae, *Miconia*, Jamaica, John Crow Mountains

RESUMEN

Miconia pseudorigida, es una especie rara y amenazada, que ha sido previamente colectada cuatro veces. Esta especie fue relocalizada y re-colectada en las montañas John Crow, aproximadamente a dos millas al suroeste de Ecclesdown. En base a nuestras observaciones de campo, fotografías y especímenes de herbario, se actualizan los detalles hasta ahora publicados de su variación morfológica y estado de conservación. Se recalca que los retoños de esta especie presentan consistentemente superficies abaxiales rojas-rosadas, una característica previamente no conocida y útil para distinguir *M. pseudorigida* de la especie relacionada *M. rigida*. Adicionalmente, se reporta por primera vez el color de la pubescencia supranodal.

Miconia pseudorigida Proctor was described by George Proctor on the basis of two specimens (Proctor 1967) collected in Portland Parish, where it grows on the east slope of the John Crow Mountains near Ecclesdown, in moist montane forests over limestone from 450–750 m. Additional collections of this rare species were made by R.A. Howard and H.A. Osmaston (see specimen citations in Judd 2007). *Miconia pseudorigida* is a member of the species-rich Antillean clade of *Miconia* sect. *Chaenopleura*, and is likely closely related to the morphologically similar *M. rigida* (Sw.) Triana, a species that is restricted to the Blue Mountains, occurring in moist montane to cloud forests on acidic soils from 1250 to 2250 m (Judd 2007). *Miconia pseudorigida* is easily distinguished from *M. rigida* by its stems, which are glabrous or have scattered minute globular-hairs, except for a conspicuous band of long-stalked gland-headed or non-glandular multicellular hairs positioned just above each node. In contrast, the stems of *M. rigida* are densely covered with rufo- or rubigino-ferrugineous to ferrugineous, elongate-branched to irregularly stellate-branched hairs intermixed with minute-globular hairs. Scattered, long-stalked, gland-headed hairs may also be present, but these are shorter than those found in *M. pseudorigida*, and do not form the consistent and conspicuous supranodal bands so characteristic of *M. pseudorigida*. In addition, the external hypanthium surface of *M. pseudorigida* is nearly glabrous, aside from a few long-stalked, gland-headed hairs, while that of *M. rigida* is densely covered by irregularly stellate to minute-globular hairs, along with at least a few, and often numerous, long-stalked gland-headed hairs. Finally, the flowers of *M. pseudorigida* are somewhat smaller than those of *M. rigida* (see Judd 2007, for details involving measurements of floral parts in these two species).

On a recent fieldtrip in Jamaica, we hiked into the Blue and John Crow Mountains National Park near Ecclesdown in the John Crow Mountains in order to locate and explore a site referred to among botanists as

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"Proctor's Pool," which is known for its floristic diversity. On this trip we discovered and re-collected *Miconia pseudorigida*; the specimen citation is provided below.

Miconia pseudorigida Proctor. **JAMAICA. Portland Parish:** John Crow Mountains, about 2 mi SW of Ecclesdown following forestry road W and then trail into eastern slopes of mountains, trail head at 18°2'49.2"N, 76°20'39.1"W, collections at 18°02'33.7"N, 76°21'7.6"W, very near "Proctor's Pool," elev. 658–660 m, beautiful, moist, elfin forest on ridge of John Crow Mountains, 21 Jan 2011, *Walter S. Judd 8329, with Gretchen M. Ionta, Jun Wen, Keron Campbell, Patrick Lewis* (FLAS, IJ, NY, UCWI).

At this locality we found a few shrubs (to 2 m tall) on a limestone ridge just above "Proctor's Pool." On the basis of our field observations, photographs, and study of herbarium specimens made at this site, we have increased our knowledge of the pattern of morphological variation in *Miconia pseudorigida*, and in the process discovered additional characters differentiating it from *M. rigida*.

Our newly collected specimens of *Miconia pseudorigida* bear multicellular gland-headed hairs up to 3 mm long (previous collections have hairs of this type up to only 2.5 mm long; see Judd 2007); non-glandular hairs, however, can reach lengths of 4-6 mm. Thus the longest glandular multicellular hairs of *M. pseudorigida* vary from 1.5-3 mm, and multicellular eglandular hairs are from 4–6 mm long. In contrast, multicellular hairs are much shorter in *M. rigida*, ranging in length from 0.3-0.5 mm. In addition, *M. rigida* does not possess the conspicuous supranodal band of multicellular hairs so evident in *M. pseudorigida* (Fig. 1). Examination of living material allowed us to describe accurately the striking coloration of these gland-headed hairs for the first time. Our observations indicate that these hairs have bright red to rose-colored stalks, with very pale to intensely yellow glandular heads (Fig 2); in contrast, Judd (2007) merely referred to these hairs as "reddish." The stems of the new growth in *M. pseudorigida* are green, being nearly glabrous, but they turn brown or greenish-brown on older shoots. In contrast, the new-growth stems of *M. rigida* are rufo- or rubigino-ferrugineous due to their dense covering of elongate-branched, irregularly stellate-branched, to minute-globular hairs. In *M. pseudorigida* the nodal region (just below the point of petiole attachment) usually has few to numerous, pale green to white, circular to elliptic or elongate, slightly raised regions. These lenticel-like structures turn brown on older branches, and become much less apparent. They were not previously observed by the first author in this species, but appear similar to, but less prominent than, the nodal lenticels reported in *M. sintenisii* Cogn., *M. howardiana* Judd, Salzman & Skean, *M. favosa* (Desr.) Naud, and relatives (Judd 2007), i.e., members of the bullate-leaved clade. Upon close inspection we also located (and report here for the first time) nodal lenticels on specimens of *M. rigida*, which are difficult to see as a result of the dense indumentum of the stems, and were not reported in Judd (2007).

The leaves of *Miconia pseudorigida* can readily be distinguished from those of *M. rigida* by their color, a finding not previously recorded (Judd 2007). The very young leaves at the apex of the new shoots of *M. pseudorigida* are red to pale red when first expanding from the bud, and when partially expanded are green with red tinges above and intensely rose-red beneath; when fully expanded the leaves of the current growth flush are green above and bright, intensely rose-red on the lamina abaxially, with the primary and secondary veins pale green. The petioles are rose-red adaxially and green abaxially. In contrast, in *M. rigida* the young, newly expanding leaves are red, becoming green and red tinged on both surfaces as they start expand, and the fully expanded leaves of the new growth flush are green above and pale green beneath, with the primary and secondary veins pale green (but with red-ferrugineous indumentum). The petioles are red or red-ferrugineous adaxially and pale green abaxially (but with red-ferrugineous indumentum). In both species the leaves of older branches are green adaxially and pale green abaxially. Thus, the fully expanded leaves of the current growth flush in *M. pseudorigida* are intensely rose-red on the lamina abaxially (Fig. 1), while those of the related *M. rigida* are pale green on the lamina of the abaxial surface (Fig. 3).

In the revision of Antillean *Miconia* sect. *Chaenopleura* (Judd 2007) only *Miconia quadrangularis* (Sw.) Naud. was reported as an associated species of *M. pseudorigida*; based on our recent collection of this rare species, we can now add the following Melastomataceae associates: *Conostegia icosandra* (Sw. ex Wikstr.) Urb., *C.* cf. *pyxidata* Proctor, *C. rufescens* Naud., *C. superba* (Bonpl. ex D. Don) Naud., *Meriania leucantha* (Sw.) Sw., *Miconia ampla* Triana, *M. ciliata* (L.C. Rich.) DC., *M. dodecandra* (Desr.) Cogn., *M. multispicata* Naud., *M.*

FIG. 1. Branch of *Miconia pseudorigida* (*Judd 8329*); note leaves with intensely rose-red abaxial surface and conspicuous supranodal clusters of gland-headed multicellular hairs.

Fig. 2. Nodal region of *Miconia pseudorigida* (*Judd 8329*) showing long-stalked, gland-headed, multicellular hairs.

Fig. 3. Leaf of current growth flush of *Miconia rigida* (*Judd 8316*) from near Blue Mountain Peak. Note pale green abaxial surface.

...ubrosa (L.) Ionta, Judd & Skean, *M. tetrandra* (Sw.) D. Don ex G. Don, and *Mecranium* (possible undescribed species).

Miconia pseudorigida is listed as endangered (ENB1+2c) in the IUCN Red List of Threatened Species (Kelly ...) because of its rarity, extremely limited distribution and fragmented habitat in the John Crow Mountains.

Our observations indicate that the habitat is intact; the species grows in a moist elfin forest, and we saw no indication of habitat fragmentation in the nearby forest. The species is, however, very rare—only a few individuals were seen on a single ridge. The species also is considered to be endangered by the Jamaican government under the Endangered Species (Protection, Conservation and Regulation of Trade) Act of 2000 (http://www.moj.gov.jm/laws/statutes/The Endangered Species (Protection, etc. Act.pdf). Fortunately, the relative inaccessibility of the populations of this rare species, and the fact that they are within a national park, provide some protection for this beautiful plant.

ACKNOWLEDGEMENTS

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TREE SPECIES ABUNDANCE AND REGENERATION POTENTIAL OF SEMI-DECIDUOUS FOREST FRAGMENTS OF THE ASHANTI REGION OF GHANA

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ABSTRACT

The objective of this study was to determine the regeneration potential of natural forest fragments in the dry semi-deciduous forest zone in the Ashanti region of Ghana. For this reason tree species abundance was studied in two distinct natural forest patches located within a teak plantation. The full sampling revealed a total of 224 individual trees belonging to 26 species and 14 families. A regeneration study using a systematic sampling design recorded a total of 46 tree species from 18 tree families. The majority of the woody species in the remnant natural forest was represented by only a few tree species. About 52% of all mature and regenerating trees were pioneer species. It could be concluded that the higher diversity among the regeneration is due to seed dispersal from outside by birds, mammals and wind. The remnant natural forests show high species abundance and can play an important role for the preservation of a floristic diversity in a converted landscape.

KEY WORDS: Forest fragments, Ghana, plantation, regeneration, species abundance.

RÉSUMÉ

L'abondance des espèces forestières a été étudiée dans un vestige de forêt naturelle de 5 ha localisée dans une plantation de tek en forêt sèche semi-décidue dans la région d'Ashanti au Ghana. Un inventaire complet de deux reliques distinctes de forêt naturelle a montré l'existence de 224 arbres vivants appartenant à 26 espèces issues de 14 familles. Une étude sur la régénération par échantillonnage systématique a montré un total de 46 espèces issues de 18 familles. La majorité des espèces ligneuses dans le vestige de forêt naturelle était représentée par quelques espèces seulement. 52% de tous les arbres matures et régénérés étaient des espèces pionnières. En conclusion, la diversité plus importante parmi les espèces en régénération pourrait être due à la dispersion des graines par les oiseaux, les mammifères et le vent. Le vestige de forêt naturelle montre une forte abondance d'espèces et peut jouer un rôle important pour la préservation de la diversité de la flore dans un paysage profondément transformé.

INTRODUCTION

The tropical forests are estimated to be the host of more than four-fifth of the world's biodiversity (FAO 2001). The rate of disappearance of tropical forests is alarming with West Africa being the hardest hit by this trend (Schroeder et al. 2010).

The forests in West African are recognized as among the most depleted and fragmented in the world and together with Central African forests they are among the most biologically unique (Hall & Swaine 1981; Hawthorne 1988; Myers 1990; Whitmore 1997; Goudie 2000; Myers et al. 2000). Fragmentation is one of the processes that accounts for species loss and loss of diversity (Hunter 1996). The major cause of fragmentation is the expanding human population converting natural ecosystems into human-dominated ecosystems. Fragmentation of habitats caused by human actions is one of the most prevalent impacts acting and modifying natural species assemblages (Ranta et al. 1999; Bolger et al. 2000; Lomolino & Perault 2000). Puhari & Murai (1999) have demonstrated the high correlation between human population density and cumulative forest loss. Agriculture, a dominant land-use technique, is a proximate cause of most fragmentation (Hunter 1996; Johns 1997; FAO 2001). Although fragmented landscapes are now becoming ubiquitous features of the tropical world (Laurance & Bierregaard 1997), fragments of original habitats located in the middle of anthropologically changed landscapes can play an important role as refuge areas for the original biodiversity and as ecological

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corridors. Exchange between the disjunct patches of habitats is essential. These forest fragments could then act as reservoirs from where native species can disperse again when conditions have changed.

Botanical assessments such as floristic composition and structure studies are vital in the context of understanding the extent of plant diversity in forest ecosystems (WCMC 1992; Addo-Fordjour et al. 2009). They are instrumental for the assessment of sustainability of forests since forests play a major role in the conservation of plant species, and ecosystem management (Tilman 1988; Ssegawa & Nkuutu 2006). Ecological data obtained in this regard are not only useful for the application of sound management practices but, among others, also beneficial in identifying important elements of plant diversity, protecting threatened and economic species and monitoring the state of forests (Tilman 1988; Ssegawa & Nkuutu 2006; Addo-Fordjour et al. 2009).

The main objective of this study was to determine the potential of the remaining forest fragments as a source of natural regeneration to neighboring teak (*Tectona grandis* L.f) plantation stands in a heavily degraded landscape which has widely changed to grasslands with only a few forest patches left with indigenous tree species. Specific objectives were to (i) determine the tree species abundance and diversity of the forest fragments and (ii) determine the regeneration potential of the tree species.

Study Area

The study was carried out in a privately owned Dupaul Wood Treatment Ltd.-plantation (7°3' N and 1°34' W) 42 km north of Kumasi, the Ashanti regional capital of Ghana. This region is located in the semi-deciduous forest zone (Hall & Swaine 1981). The soils are comparatively rich in nutrients and ideal for the cultivation of cocoa and other cash crops. The identified soils in the plantation area are predominantly sandy and the cation exchange capacity indicates that the nutrient supply from the clay fraction and organic matter is sufficient and suitable for the cultivation of trees (Kuester 2003). The annual rainfall varies between 1200 mm and 1800 mm.

The plantation site covers a total area of 164 hectares, which is grouped into four vegetation areas: the tree plantation area, grassland area, farmlands, and remnants of natural forest. The grassland area was burnt by fires in previous years. The tree plantation area was afforested mainly with teak, to a lesser extent with pine (*Pinus oocarpa* Schiede ex Schltdl., *Pinus caribaea* var. *hondurensis* Morelet, *Pinus taeda* L., and *Cedrela odorata* L. This area is divided in different planting blocks with planting periods from 1995 to 2003 (Ackermann & Kuester 2004).

METHODS

Two remaining forest fragments (5 ha in size) were completely inventoried following standard forest inventory procedures as described by Koehl et al. (2006). No herbarium vouchers were collected. All trees (≥ 10cm diameter at breast height (1.3 m), DBH) were counted, tagged and identified to the species level using fresh material. Staff at the Forestry Department Herbarium in Kumasi assisted with identifications. Tree heights were assessed to the nearest decimetre by using a Suunto hypsometer. The DBH were measured with a diameter measure tape to the first decimal place. In case of stem form anomalies at 1.3 m height the diameter was determined by the mean of measurements above and below the irregularity. The diameter of oil palms (*Elaeis guineensis* Jacq.) was not assessed due to heavy branching all over the trunks. All botanical nomenclature in this paper follows Hawthorne and Jongkind (2006).

The dominance (basal area) and abundance values (total and proportional) of each tree with a DBH of 10 cm or more were calculated from the inventory data as described by Lamprecht (1989). Hoheisel (1976) has shown that there is a straight linear correlation between crown and stem diameters. Since the determination of crown projection is difficult, total dominance (TD) was calculated as basal area from the measured DBH (Hoheisel 1976; Lamprecht 1989; Wattenberg & Breckle 1995). The relative or proportional dominance (PD) was calculated as the percentage of a tree species of the total basal area in the study plot. Total abundance (TA) was calculated as the stem number of a given species per area while the proportional or relative abundance (PA is the percentage of the total stem number per area.

To estimate the regeneration potential, a grid of 50 m × 50 m was laid out based on an existing 250 m × 250 m grid on a map. Circular sampling plots with a radius of 10.30 m were systematically located at the inter-

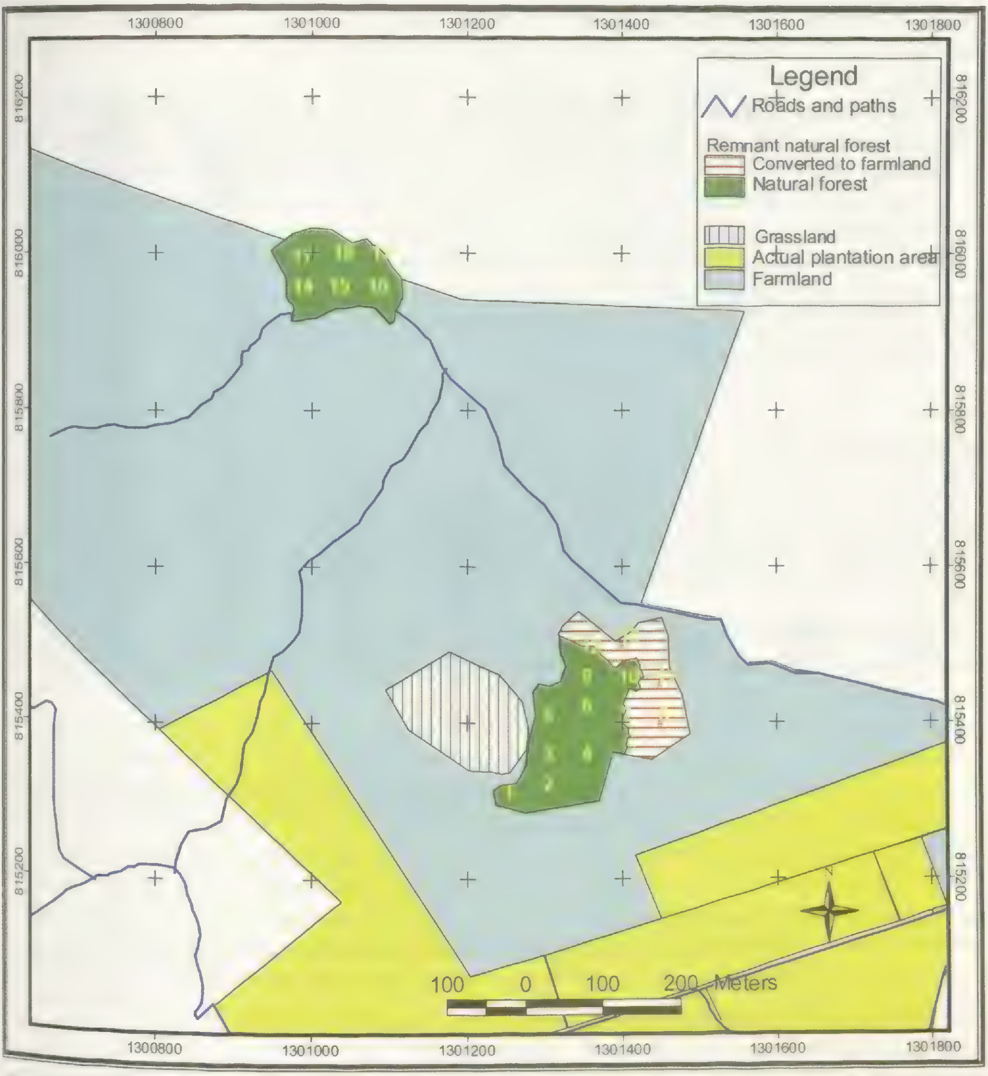

FIG. 1. Map of portions of Papasi plantation showing the sampling points within the forest fragments and the complete grid of the plantation area.

sections of the universal transverse mercator (UTM) grid. The systematic sampling design was used because it is representative and ideal for repeated inventories since long term research is planned for this plantation. The positions of the plots were located in the field with a Global Position System (GPS) instrument (GeoExplorer III) and marked permanently to ensure that plots are located again in the next inventory. A total of 19 sampling points was located in the two forest fragments, 6 on the forest fragment located at the northern border and 13 sampling points on the forest fragment in the middle of the plantation (Fig. 1). As a rule of thumb, any sampling point that was inaccessible was shifted 12 m to the north.

All small trees above a height of 1.30 m and below a diameter of 10.0 cm (regeneration class 1) were recorded. Smaller squared plots of 100 m^2 were located in the larger plots for the survey of young individuals between 0.50 m and 1.30 m height (regeneration class 2). Small trees of 30 to 50 cm height (regeneration class

3) were recorded in 25 m² plots. For the estimation of seedlings below 30 cm, circular subplots of 3.14 m² were laid out within the 25 m² plots. All individuals in these regeneration plots and subplots were counted by species.

Guilds are ecological groupings of species that can be used to describe functional traits of different types of trees (Hawthorne 1993). Tree species differ in their responses to gaps where more light is available. This differentiation can be used as the basis for categorising forest trees into ecological guilds. Species are classified into (1) pioneer trees, which germinate and grow in canopy gaps or under open conditions and (2) non-pioneer trees which tolerate forest shade (Swaine & Whitmore 1988). Pioneer species are highly competitive in disturbed forests (Agyeman 2000). Non-pioneer tree species are further subdivided into semi-shade-tolerant species and shade-bearers (Lamprecht 1989). Semi-shade-tolerant species are found only as seedlings in the twilight zone and require gaps to develop further. Shade-bearers on the other hand are trees found in all sizes in the twilight zone (Hawthorne 1993).

RESULTS

General findings

A total of 224 individual trees with DBH ≥ 10 cm belonging to 26 species and 14 families were found on the 5 hectares of remnant forest. The oil palm *Elaeis guineensis* Jacq. showed the greatest number with a total of 77 (34%) palm trees. *Bombax buonopozense* P. Beauv. was represented with a total of 39 trees. The majority of species in the remnant natural forest was represented by only few trees. Eight (8) species were found with only one individual.

The total basal area—excluding oil palms—in the two forest fragments was 45.69 m² (i.e. 9.00 m² / ha). *Bombax buonopozens* P. Beauv. recorded the greatest basal area with 15.33 m² while *Nesogordonia papaverifera* A. Chev. only measures 0.01 m.

It can be observed from Table 1 that the most abundant tree species are also the most dominant ones. This is illustrated by the following species: *Bombax buonopozense* P. Beauv., *Ceiba pentandra* L., *Mangifera indica* L. and *Spathodea campanulata* P. Beauv. In the case of *Broussonetia papyrifera* L'Hér. ex Vent., however, this pattern was not followed. This species recorded a high percentage of abundance (7.14), but a very low percentage of dominance (1.39), which indicates these trees remain in the narrow diameter class. *B. papyrifera* L'Hér. ex Vent., the paper mulberry tree, is an exotic tree species from east and southeast Asia. The fast growing species was introduced to Ghana with the purpose to produce fuel wood. Beyond cultivation the tree species regenerated rapidly and spread naturally. Today the species is regarded as invasive to Ghana (IUCN 2009). The dominance value of oil palm could not be calculated because diameter measurements were not taken for this species.

Floristic Structure

The forest fragments attained a maximum height of 36 m with only 1.34% of all trees constituting the highest layer of trees. The tree height distribution shows a hyperboloid function (Fig. 2). The lower height classes recorded more numbers of trees.

The DBH distribution featured a similar function as that of the tree heights with many small and only few thick trees. DBH values ranged from 10 cm to 217 cm. Figure 3 shows the number of trees in the various DBH classes.

Regeneration

The regeneration study revealed a total of 46 tree species in all 19 sampling sites representing 18 tree families with Moraceae accounting for 39%, thus being the most abundant family. The regeneration class 2 and 3 showed the highest number (N = 333) of regenerating plants per hectare. Regeneration class 1 featured the lowest number of regenerating trees with only 18% of the total regenerating plants. The average number of trees per hectare in the various regeneration height classes is illustrated in Figure 4. However six tree species *Vernonia amygdalina* Delile, *Macaranga heterophylla* Müll.Arg., *Millettia zechiana* Harms, *Massularia acuminata* (G. Don) Bullock ex Hoyle, *Glyphaea brevis* (Spreng.) Monach. and *Baphia nitida* Lodd.recorded as regenerating

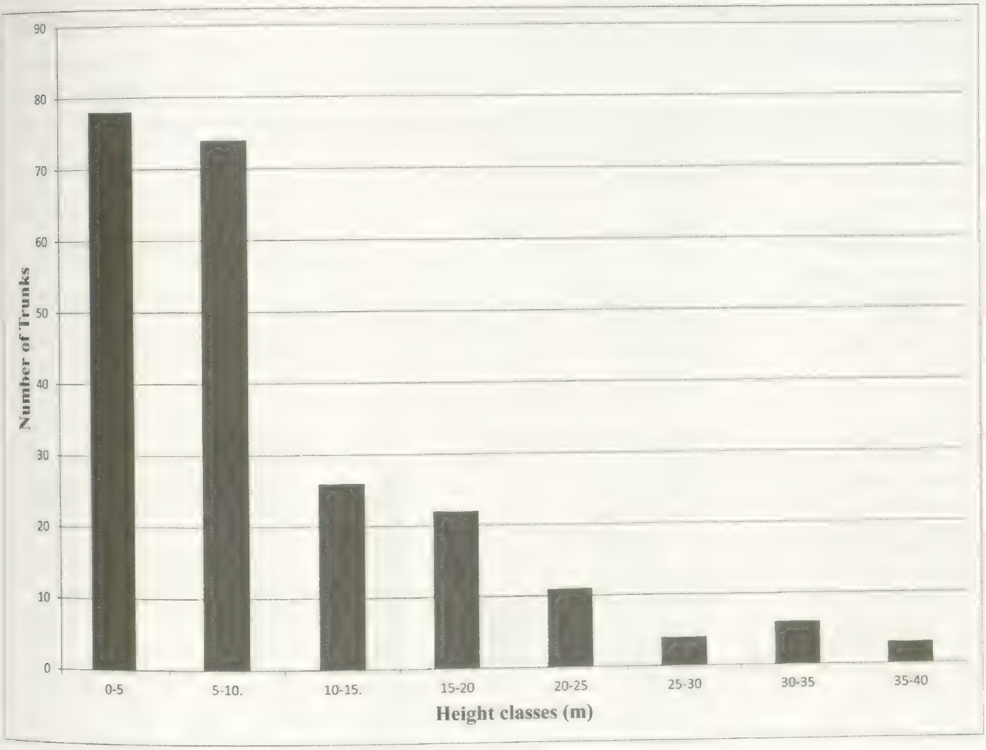

FIG. 2. The distribution of individual tree species (≥ 10 cm DBH) within the various height classes (m).

plants may be fully grown trees since literature (Hawthorne & Jongkind 2006) describe them as small trees growing up to a maximum height of between 8–10 m.

During this research it could be observed that various tree species regenerated under thick grass cover except under the composite species *Chromoleana odorata*, an invasive weed species.

Species guilds

Trees were classified into the described species guilds (Table 2) according to Hall and Swaine (1981) and Hawthorne (1993; 1994).

About 52% of all mature and regenerating trees recorded in the forest fragments are pioneer species while 48% are non-pioneer species. When the non-pioneer species are further divided into semi-shade-tolerant species and shade-bearers 28% of the non-pioneer species are semi-shade-tolerant while 20% are shade-bearers.

DISCUSSION

The vital role that floristic composition and structure play for the conservation of plant species, sustainability of forests and the management of forest ecosystems as a whole is well acknowledged (Tilman 1988; Ssegawa & Nkuutu 2006; Addo-Fordjour et al. 2009). Few studies (Hall & Swaine 1981; Vordzogbe et al. 2005; Anning et al. 2008; Addo-Fordjour et al. 2009) have been conducted in Ghana, the results of our research is compared to the above. The tree species inventory within the forest fragments showed a low species abundance. The average number of 45 trees / ha is very low compared to 552 trees / ha in a moist semi-deciduous forest at Kade, Ghana (Swaine et al. 1987). Swaine and Whitmore (1988) state a wide range of tree numbers (395–734 / ha ≥ 10 cm DBH) for tropical forests from three continents. For semi-deciduous forests in Venezuela, Lamprecht (1989) recorded a range of 284–333 stems / ha. The reason for the low tree appearance in the surveyed forest patches

TABLE 1. Total and proportional abundance (TA, PA) and the total and proportional dominance (TD, PD) of all trees with a DBH of 10 cm or more in the remnant natural forest patches. The trees are arranged alphabetically by species (n.d. = not determined).

Species	Family	TA (N)	PA (%)	TD (m^2)	PD (%)
Albizia ferruginea	Mimosaceae	1	0.45	0.93	2.02
Albizia zygia	Mimosaceae	4	1.79	0.16	0.35
Alstonia boonei	Apocynaceae	4	1.79	1.12	2.46
Antiaris toxicaria	Moraceae	2	0.89	1.59	3.47
Bombax buonopozense	Bombacaceae	39	17.41	15.33	33.54
Borassus aethiopium	Palmae	3	1.34	0.25	0.54
Broussonetia papyrifera	Moraceae	16	7.14	0.63	1.39
Ceiba pentandra	Bombacaceae	10	4.46	8.91	19.51
Cola gigantea	Sterculiaceae	4	1.79	7.38	16.15
Cordia senegalensis	Boraginaceae	3	1.34	0.20	0.43
Elaeis guineensis	Palmae	77	34.38	n.d.	n.d.
Ficus exasperata	Moraceae	1	0.45	0.03	0.06
Ficus sp.	Moraceae	6	2.68	1.75	3.82
Glyphaea brevis	Tiliaceae	6	2.68	0.64	1.41
Khaya ivorensis	Meliaceae	1	0.45	0.70	1.53
Lannea welwitschii	Anacardiaceae	1	0.45	0.06	0.13
Mangifera indica	Anacardiaceae	17	7.59	1.30	2.85
Margaritaria discoidea	Euphorbiaceae	2	0.89	0.41	0.90
Nesogordonia papaverifera	Sterculiaceae	1	0.45	0.01	0.02
Newbouldia laevis	Bignoniaceae	2	0.89	0.10	0.22
Ricinodendron heudelotii	Euphorbiaceae	2	0.89	1.14	2.49
Spathodea campanulata	Bignoniaceae	17	7.59	2.35	5.13
Tetrapleura tetraptera	Mimosaceae	2	0.89	0.02	0.04
Trema orientalis	Ulmaceae	1	0.45	0.03	0.07
Trichilia tessmannii	Meliaceae	1	0.45	0.62	1.36
Triplochiton scleroxylon	Sterculiaceae	1	0.45	0.05	0.11
26 species	14 families	224	100.00	45.69	100.00

is due to former logging operations and shifting cultivation practices. 90% of all trees ≥ 10 cm DBH showed abiotic damages on roots, buttresses or crowns caused by fire or felling activities. The two forest fragments are not protected and surrounded by other land-use forms. The fact that the studied forest fragments are degraded could have accounted for the low density of trees compared to what have been recorded elsewhere.

Although the calculation of tree species' diversity by dividing the total number of species by the recorded area is systematically incorrect, it was done here to compare survey results with those of other authors from Ghana. The tree species' diversity of 5 species per ha determined in this study is very low compared to 37 species / ha assessed by Anning et al. (2008) in a disturbed semi-deciduous forest. In a similar forest type Addo-Fordjour et al. (2009) recorded 48 tree species / ha in the Tinte Bepo Forest Reserve and Vordzogbe et al. (2005) calculated a tree species diversity of 80 species / ha in the same forest type.

The Simpson's reciprocal diversity index determines the number of species in relation to the abundance of each species. A low value represents little, a high value great diversity. In the remnant forest Simpson's reciprocal diversity index was 6.02, calculated for all trees ≥10 cm DBH. Thus, the diversity of trees in the surveyed remnant natural forest was low compared to the maximum diversity of 26. Although species diversity indices have been criticized, they are still widely used in plant and animal ecology to evaluate, survey, and conserve ecosystems (Mouillot & Leprêtre 1998).

Similar to the tree species diversity the average total dominance (basal area) of 9.14 m^2 / ha is also minor compared to values recorded in disturbed forests at Kade with 30.85 m^2 / ha (Swaine et al. 1987) and the range of 28 to 52 m^2 / ha stated by Swaine and Whitmore (1988) for tropical countries and Lamprecht (1989) who reports 29 m^2 / ha from Venezuela. The low value in dominance is partly due to the presence of oil palms which have not been measured as explained above and is partly caused by logging and shifting cultivation activities.

Almost all floristic structure and general stand parameters indicate that the surveyed remnant natural

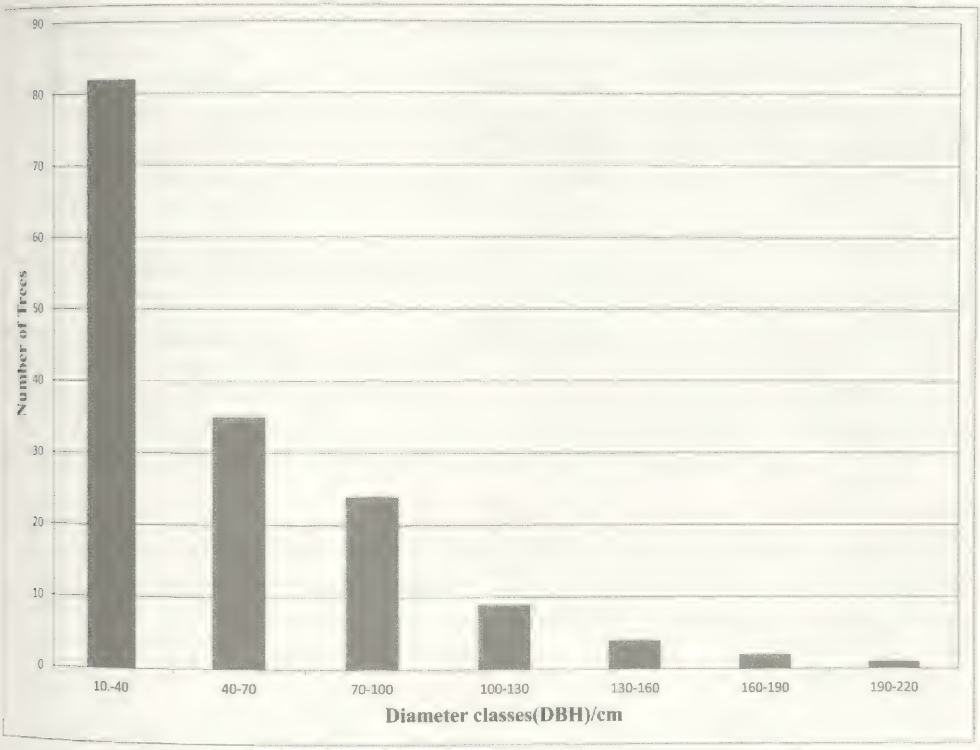

FIG. 3. Number of trees in the various DBH classes.

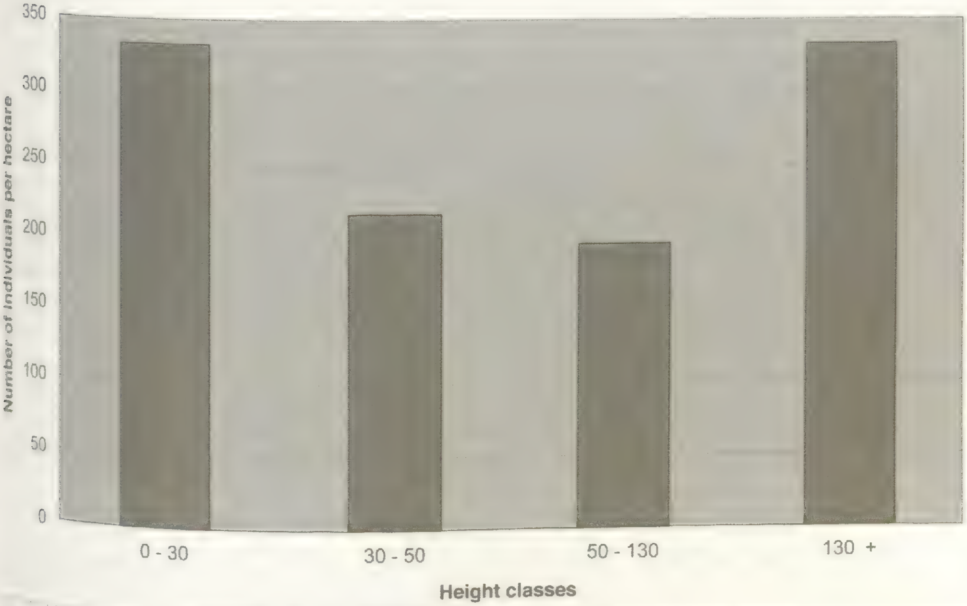

FIG. 4. Number of individual regenerating plants in different height classes.

TABLE 2. Classification of trees species into guilds.

Pioneer species	Non-pioneer species Semi-shade-tolerant	Shade-tolerant
Alstonia boonei	*Albizia adianthifolia*	*Baphia nitida*
Bombax buonopozense	*Albizia ferruginea*	*Blighia unijugata*
Borassus aethiopium	*Albizia zygia*	*Blighia sapida*
Broussonetia papyrifera	*Antiaris toxicaria*	*Cola caricifolia*
Ceiba pentandra	*Cola gigantea*	*Deinbollia grandifolia*
Cordia senegalensis	*Entandrophragma utile*	*Funtumia elastica*
Elaeis guineensis	*Glyphaea brevis*	*Hymenostegia afzelii*
Erythroxylum mannii	*Khaya ivorensis*	*Lannea welwitschii*
Ficus exasperata	*Myrianthus arboreus*	*Mallotus oppositifolius*
Ficus sp.	*Myrianthus libericus*	*Massularia acuminata*
Ficus sur		*Millettia zechiana*
Holarrhena floribunda		*Microdermis keayana*
Lecaniodiscus cupaniades		*Nesogordonia papaverifera*
Macaranga heterophylla		*Tetrapleura tetraptera*
Mangifera indica		*Trichilia monadelpha*
Mareya micrantha		
Margaritaria discoidea		
Morinda lucida		
Morus mesozygia		
Milicia excelsa		
Newbouldia laevis		
Rauvolfia vomitoria		
Ricinodendron heudelotii		
Sterculia tragacantha		
Spathodea campanulata		
Terminalia ivorensis		
Trema orientalis		
Triplochiton scleroxylon		
Vernonia amygdalina		

forest in Ghana's Ashanti region is highly degraded. It has a low number of trees, fewer tree species and small basal area per hectare as compared to other forest types of its kind, i.e. the semi-deciduous forest. The height and diameter classes follow a similar pattern with more trees in the lower height and diameter classes. The maximum height (36 m) and diameter (218 cm) are however typical for deciduous forests in Ghana (Addo-Fordjour et al. 2009). The great number of pioneer trees in the lower layers of the tree canopy is an indication of a secondary forest.

The analysis of the regeneration data indicate that almost twice the number of species (46) and families (18) are present than among the mature trees (26). In comparison Addo-Fordjour et al. (2009) report only 29 tree species from 12 families from the Tinte Bepo Forest Reserve. This suggests that the remnant forest surveyed in this study still has a vigorous regeneration potential and that seed dispersal vectors are active.

Consequently we analysed the possible ways how the new tree species got into the forest fragments. Most probably these seeds do not originate from the soil seed bank as no mature individuals of these species exist in the forest fragments. Though there are no other natural forests present in the area and far beyond, wind, birds and mammals are possible vectors of seed dispersal. Wind plays an important role in the dissemination of pioneer species' seeds, which are light, often winged and can be carried to considerable distances. The recorded small tree species *Vernonia amygdalina* is an example for seed dispersal by wind.

Birds and mammals, especially flying foxes, are however the most likely dispersal vectors because they move and can carry seeds over long distances. Regular observations of different bird and bat species within the remnant forest underline our assumption which also corresponds with the findings of Swaine and Whitmore (1988) and Whitmore (1990) while Sayer el al. (1992) identified the role of animals for seed dispersal and forest

rehabilitation processes. In this context remnant natural forests hold an important function as they can serve as retreat and corridor for plants and animals in fragmented landscapes. Thus, forest patches contribute to the preservation of biodiversity.

The absence of tree regeneration under the invasive species *Chromolaena odorata* calls for weed control in the remnant forest patches. Agyeman (2000) states that *Broussonetia papyrifera* could be used to effectively control the spread of herbaceous invasive species like *C. odorata*, but this appears not to be a valid solution since *B. papyrifera* itself is an invasive species and an efficient coloniser. The devastating effects of *B. papyrifera* on the regeneration of some native species have been documented in Ghana (CSIR 2002). Research to find an efficient way of controlling *B. papyrifera* in natural forests is therefore required.

Our forest inventory and data analysis revealed that the surveyed remnant natural forest is seriously degenerated in terms of structure and composition but it still holds a regeneration potential and contributes to the preservation of biodiversity. To maintain these functions appropriate measures in form of protection and effective silvicultural practices should be applied. If this succeeds, the natural forest patches might become richer in species number, growing stock and even more diverse in the near future. Thus, these last remnant forest pockets serve as retreat for native floristic diversity in a highly converted environment.

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SMALL-SCALE VASCULAR PLANT SPECIES RICHNESS IN SOUTHWESTERN ARKANSAS BLACKLAND PRAIRIES

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ABSTRACT

We describe the small-scale (0.0001, 0.001, 0.1 ha.) species richness and soils of blackland prairies in southwestern Arkansas. Areas sampled were Saratoga Blackland Prairie Natural Area, Rick Evans Grandview Prairie Wildlife Management Area, and Terre Noire Natural Area. Four 0.1 ha plots had 134 species and averaged 64.8 species, eight 0.001 ha plots averaged 22.1 species, and eight 0.0001 ha plots averaged 14.5 species. The most diverse families were Asteraceae (37 species), Poaceae (23 species), and Fabaceae (11 species). The soils are predominantly alkaline high-calcium silty clay loams. The soils are similar to those of other blackland/isolated prairies in the southeast except for their higher calcium levels. Ninety-eight percent of the species were native. The occurrence of only three exotic species in the plots indicates that these sites are in very good condition.

RESUMEN

Describimos a pequeña escala (0.0001, 0.001, 0.1 ha.) la riqueza de especies y suelos de las praderas negras del suroeste de Arkansas. Las áreas muestreadas fueron Saratoga Blackland Prairie Natural Area, Rick Evans Grandview Prairie Wildlife Management Area, y Terre Noire Natural Area. Cuatro parcelas 0.1 ha tenían 134 especies y una media de 64.8 especies, ocho parcelas 0.001 ha una media de 22.1 especies, y otras ocho de 0.0001 ha una media de 14.5 especies. Las familias más diversas fueron Asteraceae (37 especies), Poaceae (23 especies), y Fabaceae (11 especies). Los suelos son predominantemente margas calizas sedimentarias alcalinas de alto contenido en calcio. Los suelos son similares a otros de praderas negras aisladas en el sureste excepto por su mayor contenido en nivel de calcio. El noventa y ocho por ciento de las especies fueron nativas. La presencia de solo tres especies exóticas en las parcelas indica que estos lugares están en muy buenas condiciones.

INTRODUCTION

While prairies are one of the most endangered plant communities in North America, they are also one of the best studied (see Sims & Risser 2000, Diggs et al. 2006 for discussion and literature). Thousands of books and papers have been written on the floristics, management, and restoration of prairies (e.g., Peacock & Schauwecker 2003 and references). Over the past few decades numerous floristic and soil surveys have increased our knowledge of prairies across the southeast (see Foti 1989, 1990; Foti et al. 2003; Carr 1993; MacRoberts & MacRoberts 1995, 1996, 2003; 2004; MacRoberts et al. 2009; Schauwecker 1996; Moran et al. 1997; Leidolf & McDaniel 1998; Brown et al. 2002; Moran et al. 2003; Peacock & Schauwecker 2003; Zollner et al. 2003; Barone 2005; Barone & Hill 2007; Bekele & Hudnell 2006; Echols & Zomlefer, 2010, Arkansas Natural Heritage Commission 2011 and literature). Particularly well described and managed are the blackland prairies of southwestern Arkansas (see Foti et al. 2003; Zollner et al. 2003, for description and literature). Foti (1989, 1990), Foti et al. (2003), and Zollner et al. (2003) give detailed descriptions of soils, geology, previous land use, and distribution of these prairies, which we will not repeat here.

The purpose of this paper is to describe the small-scale (0.0001, 0.001, 0.1 ha.) floristic richness of blackland prairies in southwestern Arkansas, to determine their geographical species affinities, and to compare them to Morse clay prairies in northwestern Louisiana.

STUDY SITES AND METHODS

We studied four blackland prairie sites in southwestern Arkansas (Figs. 1–2). These were:

FIG. 1. Blackland prairie: Grandview One.

1) Saratoga Blackland Prairie Natural Area: Howard Co. 33°45'27.76"N 93°54'56.10"W. Elevation 119 m. Demopolis/Sumpter soil series (Hoelscher et al. 1975). Owned and managed by Arkansas Natural Heritage Commission, acquired in 2004.

2) Rick Evans Grandview Prairie Wildlife Management Area. Prairie One. Hempstead Co. 33°48'00.87"N 93°48'00.00"W. Elevation 130m . Demopolis/Sumpter soil series (Hoelscher & Laurent 1979). Owned and managed by Arkansas Game and Fish Commission, acquired in 1997.

3) Rick Evans Grandview Prairie Wildlife Management Area. Prairie Two. Hempstead Co. 33°48'31.98"N 93°46'57.78"W. Elevation 123 m. Demopolis/Sumpter soil series (Hoelscher & Laurent 1979). Owned and managed by Arkansas Game and Fish Commission, acquired in 1997.

4) Terre Noire Natural Area. Clark Co. 34°04'22.41"N 93°10'42.39"W. Elevation 84 m. Sumpter soil series (Hoelscher 1987). Owned and managed by Arkansas Natural Heritage Commission and The Nature Conservancy, acquired from 1991 to 2009.

More information can be found on these prairies on the web (Arkansas Natural Heritage Commission 2011

In each prairie site we established one 0.1 ha study plot away from prairie edge. We selected in each case an area that looked "typical" of that prairie. All plots were on a slight slope; they did not straddle ridgetops. Each plot measured 20 m × 50 m or 31.6 m × 31.6 m (0.1 ha). Within each 0.1 ha plot were two nested 3.16 m × 3.16 m (0.001 ha) plots. Each of these in turn had a 1 m × 1 m (0.0001 ha) nested plot within it. Thus, there were four 0.1 ha plots, eight 0.001 ha plots, and eight 0.0001 ha plots. We surveyed each plot for total species. All species in the plots were recorded every month over a year between 16 April and 5 November 2010. A specimen of most species was collected and deposited at the Arkansas Natural Heritage Commission herbarium (ANHC)

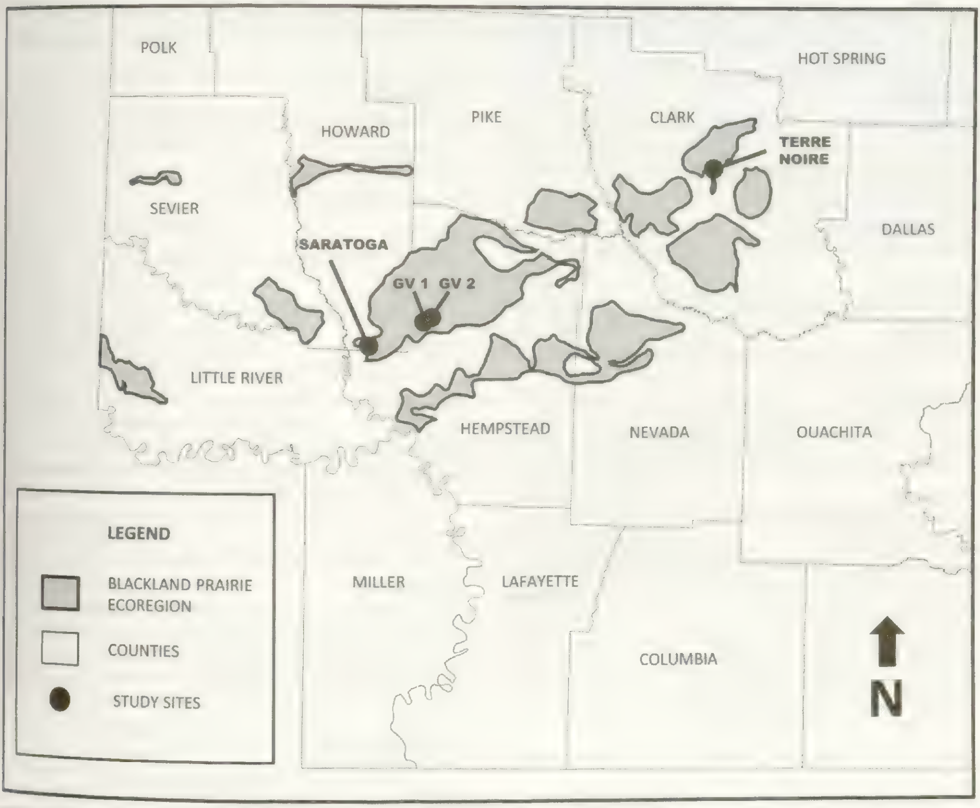

Fig. 2. Location of study sites in southwestern Arkansas.

Nomenclature generally follows Kartesz and Meacham (2005) and *Flora of North America* (1993–2006). The main floras used to identify plants were Smith (1994), Diggs et al. (1999, 2006), Yatskievych (1999–2006), and *Flora of North America* (1993–2006).

We collected soil samples from the upper 20 cm in the center of each 0.1 ha plot. These were analyzed for pH, various elements, and soil texture at Louisiana State University Soil Testing and Plant Analysis Laboratory.

Using Sorenson's Index of Similarity we compared the four study plots and these with Morse clay prairies of northwestern Louisiana that we studied previously using the same plot design as used in the present study (MacRoberts et al. 2009).

Using the list of species we found in the four Arkansas prairies and data from *Flora of North America* (1993–2006), NatureServe (2011), USDA Plant Database (2011), and Kartesz and Meacham (2005), we plotted the North American distribution of native species found in the plots by state, region, or province to determine the geographic affinities of Arkansas blackland prairies.

All sites in our sample at one time had been hayfields with light to heavy grazing and fire suppression (Arkansas Natural Heritage Commission 2010). They are now being restored by clearing invasive woody vegetation (e.g., *Juniperus virginiana*) and by prescribed fire (Akin et al. 2009).

RESULTS

The four 0.1 ha plots had a total of 134 species: Saratoga had 66, Grandview One had 49, Grandview Two had [illegible], and Terre Noire had 85. They averaged 64.8 species (Table 1). Eight 0.001 ha plots averaged 22.1 species,

TABLE 1. Vascular flora of four Arkansas blackland prairie plots (S = Saratoga, GV1 = Grandview One, GV2 = Grandview Two, TN = Terre Noire. (* = exotic species). All species were collected by B.R. & M.H. MacRoberts. Numbers following the species refer to those collections. No number = no collection.

Acanthaceae
Ruellia humilis Nutt.; S 8593, GV1, GV2

Apiaceae
**Daucus carota* L.; GV2 8565, TN 8647
Eryngium yuccifolium Michx.; TN
Polytaenia nuttallii DC.; S 8522
Zizia aurea (L.) W.D. J. Koch; TN

Apocynaceae
Apocynum cannabinum L.; GV2 8562, TN

Aquifoliaceae
Ilex decidua Walter; S, GV1, GV2, TN

Asclepiadaceae
Asclepias tuberosa L.; S 8589, GV1, GV2
Asclepias viridis Walter; S 8606, GV1 8536, GV2, TN
Asclepias viridiflora Raf.; S 8629, GV1, GV2 8690, TN

Asteraceae
Ambrosia bidentata Michx.; TN 8707
Ambrosia trifida L.; GV2
Arnoglossum plantagineum Raf.; S 8600, GV1, GV2, TN
Brickellia eupatorioides (L.) Shinners; S 8713
Coreopsis lanceolata L.; TN
Echinacea pallida (Nutt.) Nutt.; S, GV1, TN
Echinacea purpurea (L.) Moench; TN 8638
Erigeron philadelphicus L.; TN 8541
Erigeron strigosus Muhl. ex. Willd.; S 8582, TN 8560, 8582
Erigeron tenuis Torr. & A. Gray; S 8525, GV1
Eupatorium altissimum L.; TN 8706, 8731
Eupatorium semiserratum DC.; GV2, TN
Gaillardia aestivalis (Walter) H. Rock; S 8584, 8603, 8716
Grindelia lanceolata Nutt.; S 8680, GV1, TN 8682
Helenium autumnale L.; GV2 8653, 8727
Helianthus grosseserratus M. Martens; TN 8734
Helianthus hirsutus Raf.; TN
Heliopsis helianthoides Sweet; S 8602
Liatris hirsuta Rydb.; S 8676, 8711
Liatris squarrulosa Michx.; S 8721, GV1, GV2 8726, TN 8704, 8737
Ratibida pinnata (Vent.) Barnhart; TN 8640,
Rudbeckia hirta L.; S, GV1, GV2, TN
Rudbeckia missouriensis Engelm; S 8677; GV1, GV2 8685; TN 8682,
Rudbeckia triloba L.; TN 8684
Silphium integrifolium Michx.; GV2 8654, 8655
Silphium laciniatum L.; S, GV1, GV2, TN
Solidago altissima L.; TN 8705,
Solidago nemoralis Aiton; S 8722, TN 8736
Solidago radula Nutt.; GV2 8728
Solidago rigida L.; S, GV1 8700, 8670, 8723, TN 8735
Symphyotricum laeve (L.) Á. Löve & D. Löve; S 8741, GV1 8746, GV2
Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve; S 8744, GV2, TN
Symphyotrichum oolentangiense (Riddell) G.L. Nesom; S 8742, TN 8733
Symphyotrichum patens (Aiton) G.L. Nesom; S 8715,
Symphyotrichum pilosum (Willd.) G.L. Nesom; GV1, GV2 8725
Vernonia baldwinii Torr.; TN
Xanthium strumarium L.; GV2 8697

Boraginaceae
Heliotropium tenellum (Nutt.) Torr.; GV1, GV2, TN 8644
Lithospermum canescens (Michx.) Lehm.; S 8519, GV1
Onosmodium bejariense DC. ex A.DC.; S, TN 8681,

Campanulaceae
Lobelia spicata Lam.; S, GV1, TN 8637, 8636

Caprifoliaceae
Lonicera sempervirens L.; TN
Viburnum rufidulum Raf.; TN 8538

Clusiaceae
Hypericum sphaerocarpum Michx.; S 8583, TN 8548

Cornaceae
Cornus drummondii C.A. Mey.; S, TN

Cuscutaceae
Cuscuta pentagona Engelm.; S 8631, GV1, GV2

Cyperaceae
Carex cherokeensis Schwein.; S 8528, GV1, GV2, TN
Carex meadii Dewey; S 8529, 8530
Carex microdonta Torr. & Hook.; S 8531, GV1, GV2, TN 8543
Scirpus pendulus Muhl.; TN, 8552

Ebenaceae
Diospyros virginiana L.; S 8605, GV1, GV2, TN

Euphorbiaceae
Croton monanthogynus Michx,; GV1 8673, GV2 8689
Euphorbia bicolor Engelm & A. Gray; S 8678, GV1, GV2, TN
Euphorbia corollata L; S 8585, 8597, GV2, TN
Tragia urticifolia Michx.; S, GV1, GV2, TN

Fabaceae
Acacia angustissima (Mill.) Kuntze; S, GV2 8686, TN
Cercis canadensis L.; S, TN
Chamaecrista fasciculata (Michx.) Greene; GV2, TN
Dalea candida Michx. ex Willd.; TN 8641
Dalea purpurea Vent.; S, GV1, GV2 8563, TN,
Desmanthus illinoensis (Michx.) MacM. ex Rob. & Fern.; GV1, GV2, TN 8642
Galactia regularis (L.) Britton, Strns, & Poggenb.; S 8633, GV1, TN
**Melilotus albus* Medik.; TN
Mimosa nuttallii (DC.) B.L. Turner; S 8592, GV2, TN
Neptunia lutea (Leavenw.) Benth.; S 8632, GV1
Rhynchosia latifolia Nutt. ex Torr. & A. Gray; TN 8643

Fagaceae
Quercus muehlenbergii Engelm.; S 8601, TN

Gentianaceae
Sabatia angularis (L.) Pursh; TN 8553, 8645

Hypoxidaceae
Hypoxis hirsuta (L.) Coville; S, TN 8523, 8546

Iridaceae
Nemastylis geminiflora Nutt.; S
Sisyrinchium campestre E.P.Bicknell; TN 8544, 8545
Sisyrinchium pruinosum E.P. Bicknell; S 8527, GV1 8534

Lamiaceae
Prunella vulgaris L.; TN
Salvia azurea Lam.; S 8718, GV1, GV2, TN
Salvia lyrata L.; S, GV1, GV2, TN

Linaceae
Linum sulcatum Riddell; S 8628, TN

Lythraceae
Lythrum alatum Pursh; GV2 8651

Table 1. Continued.

Melanthiaceae
Zigadenus nuttallii A. Gray; S 8518

Onagraceae
Gaura demareei P.H. Raven & D.P. Greg.; GV1, GV2, TN 8701
Oenothera speciosa Nutt.; GV2
Stenosiphon linifolius (Nutt.) Heynh.; S 8679, GV1

Oxalidaceae
Oxalis violacea L.; GV1, GV2 8535

Poaceae
Andropogon gerardii Vitman; S 8720
Andropogon glomeratus (Walter) Britton, Strns, Poggenb.; GV2, TN
Andropogon virginicus L.; GV2 8748
Aristida oligantha Michx.; GV2 8730
Aristida purpurascens Poir.; S 8714
Bothriochloa laguroides (DC.) Herter ; GV2 8729, 8747, 8750, 8751
Bouteloua curtipendula (Michx.) Torr.; S 8630
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark; TN 8549
Dichanthelium oligosanthes (Schult.) Gould; GV1 8568, GV2
Eragrostis hirsuta (Michx.) Nees.; GV2 8696, TN 8732
Eragrostis spectabilis (Pursh) Steud.; S, GV1 8745
Panicum anceps Michx.; GV2, TN
Panicum capillare L.; GV2 8696a
Panicum flexile Scribn.; TN 8732a
Panicum virgatum L.; TN
**Schedonorus arundinaceus* (Schreb.) Dumort; GV1 8570, GV2 8561
Schizachyrium scoparium (Michx.) Nash; S, GV1, GV2, TN
Setaria parviflora (Poir.) Kerg.; GV1 8569, GV2, TN
Sorghastrum nutans (L.) Nash; S 8719, GV1, GV2, TN
Sphenopholis obtusata (Michx.) Scribn.; GV1 8566, TN 8555
Sporobolus compositus (Poir.) Merr. var. *compositus*; GV 2 8649
Sporobolus clandestinus (Biehler) Hitchc.; GV1, GV2 8749
Tridens flavus (L.) Hitchc.; S, TN 8753

Polygalaceae
Polygala verticillata L.; GV2 8650

Ranunculaceae
Anemone berlandieri Pritz.; S 8521, GV1
Anemone virginiana L.; TN 8646
Delphinium carolinianum Walter; S 8588

Rhamnaceae
Ceanothus herbaceus Raf.; GV1
Frangula caroliniana (Walter) A. Gray; S, TN 8540

Rosaceae
Fragaria virginiana Mill.; S, TN 8539
Rosa carolina L.; GV1, GV2, TN 8550
Rosa setigera Michx.; S 8604

Rubiaceae
Houstonia longifolia Gaertn.; TN 8558
Spermacoce glabra Michx.; GV2 8652, 8688
Stenaria nigricans Terrell.; S 8586, TN

Scrophulariaceae
Agalinis heterophylla (Nutt.) Small ex Britton; GV2 8724
Penstemon cobaea Nutt.; S
Penstemon digitalis Nutt. ex Sims; GV2 8564

Smilacaceae
Smilax bona-nox L.; TN

Valerianaceae
Valerianella radiata (L.) Dufr.; TN 8547

Verbenaceae
Glandularia canadensis (L.) Nutt.; S 8520, GV1, TN
Verbena simplex Lehm.; GV1 8567, TN

and eight 0.0001 ha plots averaged 14.5 species (Table 2). Asteraceae, Poaceae, and Fabaceae dominated with 37, 23, and 11 species, respectively. Sorenson's Index of Similarity among the four prairies shows a range between 42.7 and 59.7 (Table 3). Soil test results are shown in Table 4. Figure 3 shows the North American distribution of native Arkansas blackland prairie species listed in Table 1.

DISCUSSION

The parts of blackland prairies within which our plots were located identify best with the community type described by Zollner et al. (2003:115) as "dry-mesic blackland prairie," with patches of "dry prairie" largely a consequence of erosion, and mesic elements on lower slopes. Species richness of these prairies appeared to be on the low side when compared with similar data from other open-habitat communities and with other southeastern prairies, for example, Morse clay prairies of northwestern Louisiana (MacRoberts et al. 2009). Four 0.1 ha plots in Morse clay prairies were 20% to 25% richer than the four Arkansas plots (see MacRoberts et al. 2009 and references). There were only three exotic species in the Arkansas plots, indicating the very good condition of these prairies (MacRoberts et al. 2008). The Sorensen's Index of Similarity among the four 0.1 ha plots ranged from 42.7 to 59.7 indicating that they border on being the same plant community: 50% similarity is generally accepted for the cutoff for same community. Why the four sites differed this much is not obvious but may have to do with the small sample size. However, we got the impression not only that each prairie was different but that each was fairly uniform (Fig. 1). In the immediate area surrounding the 0.1 ha plots, there were only 10 species that did not occur in any plot, which seems to confirm our subjective impression of floristic uniformity across large prairie areas. The soils of all the prairies are similar and consist of Demopolis/Sumter series, which occurs on a deep mantle of black soil high in organic matter over a substrate of Cretaceous chalk

Table 2. Species richness in Arkansas blackland prairies.

Plot and plot size (ha)	No. of plots	Average species (range)
Saratoga Prairie		
0.0001	2	14.5(14–15)
0.001	2	26.5(26–27)
0.1	1	66
Grandview One Prairie		
0.0001	2	13(10–16)
0.001	2	20(19–21)
0.1	1	49
Grandview Two Prairie		
0.0001	2	12(12–12)
0.001	2	18.5(17–20)
0.1	1	59
Terre Noire Prairie		
0.0001	2	18.5(10–27)
0.001	2	23.5(13–34)
0.1	1	85
Total		
0.0001	8	14.5(10–27)
0.001	8	21.1(13–34)
0.1	4	64.8(49–85)

Table 3. Index of Similarity (Sorenson's) among four Arkansas blackland prairies (S = Saratoga; GV1 = Grandview One, GV2 = Grandview Two, TN = Terre Noire). Formula is (2C/(A + B) × 100 where C = number of species in common between two samples, A = total species in sample A, and B = total species in sample B.

	S	GV1	GV2	TN
S	–	–	–	–
GV1	42.7	–	–	–
GV2	42.9	59.7	–	–
TN	57.0	47.7	47.6	–

Table 4. Soils data for Arkansas backland prairies.

Sample	pH	Calcium (ppm)	Copper (ppm)	Magnesium (ppm)	Phosphorous (ppm)	Potassium (ppm)	Sodium (ppm)	Sulfur (ppm)	Zinc (ppm)	Soil Texture
Saratoga	7.7	24,488	0.895	107	4.6	276.8	13.8	8.7	1.8	Silty clay loam
Grandview One	7.8	18,809	1.181	137	3.9	266.4	14.8	10.1	1.2	Silty clay
Grandview Two	7.8	19,177	1.000	151	2.4	266.7	19.5	7.8	1.2	Silty clay
Terre Noire	7.7	15.940	0.974	102	5.8	234.3	11.8	10.2	1.5	Silty clay loam

or marl (Foti 1989; Hoelscher et al. 1975; Hoelscher & Laurent 1979; Hoelscher 1987). The soils of all Arkansas blackland prairies are very similar to soils in prairies across the southeast, except for their very high level of calcium: twice to four times that of most southeastern prairies (MacRoberts & MacRoberts 1995, 1996; MacRoberts et al. 2003, 2009; Brown et al. 2002; Echols & Zomlefer 2010). As can be seen in Figure 3 the Arkansas blackland prairies are floristically decidedly eastern and central. Comparisons among the native flora of the Arkansas blackland prairies and Morse clay prairies in northwestern Louisiana give an index of similarity (Sorenson's) of 46, again indicating that they border on being the same community.

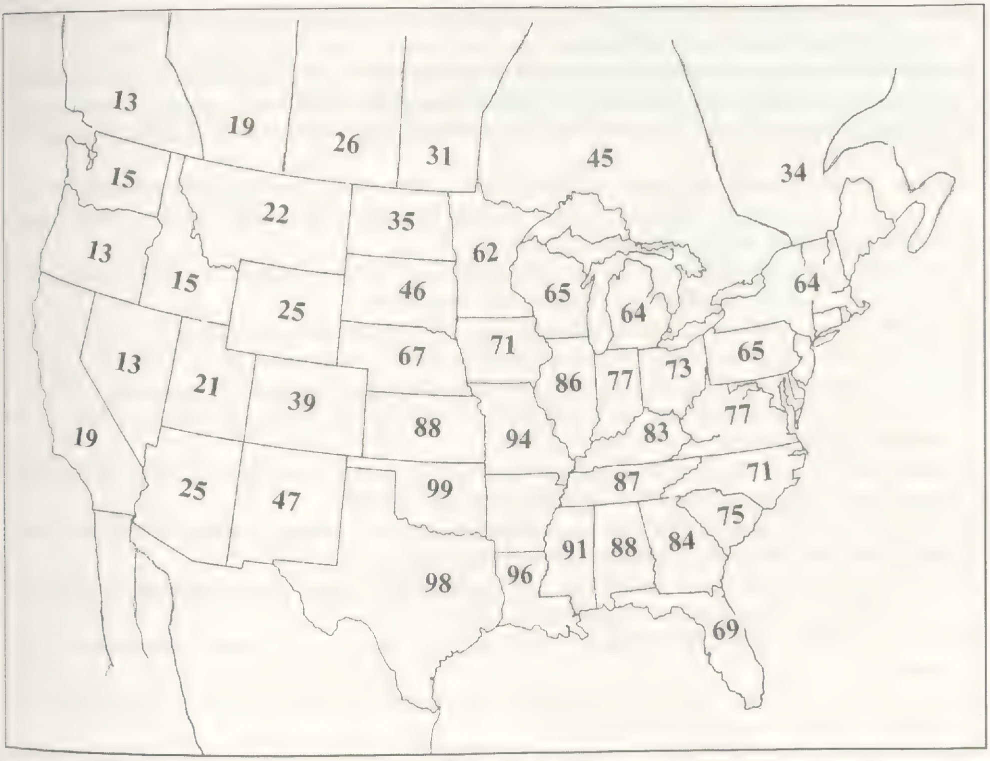

FIG. 3. North American distribution of native Arkansas blackland prairie species. Numbers are percent of total that occur in state, province, or region.

ACKNOWLEDGMENTS

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BOOK REVIEW

Sara Oldfield. 2010. **Botanic Gardens: Modern-Day Arks.** (ISBN-13: 978-0-262-01516-5, hbk.). MIT Press, 55 Hayward Street, Cambridge, Massachusetts 02142-1493, U.S.A. (**Orders:** www.mitpress.mit.edu, 800-405-1619). $29.95, 240 pp., 10½" × 8½".

Botanic Gardens: Modern-Day Arks, a book by Sara Oldfield, offers the reader an insight to many botanical gardens of the world and precautions that are taken to ensure that these gardens remain protected from any harm. Images of numerous botanical gardens of the world and the species of plants which encompass them enable the pages of Oldfield's book to stand out. These vivid images are the best part of her entire book because they show every detail of each plant even down to there extensive root system. By providing such unique images it is almost as if Oldfield is placing you directly into the botanical gardens from which these plants hail. Despite a lot of information given about necessary precautions needed to conserve such plant species, and information on the types of flora which inhabit many parts of the world, Sara Oldfield could have utilized the immense amount of extra blank space throughout her book to incorporate more information on the living environments of the plants she mentions.

Oldfield does a really great job in elaborating about plant species threatened of extinction and programs built on how to restore the habits necessary for these plants to thrive in. This book could be of good use during field work seeing how it provides some very useful information on plant species, but the book itself is too bulky to carry around from location to location and does not have an easily accessible reference guide.—*Chloe Otieno, Volunteer, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

A FLORISTIC INVENTORY OF THE CIMARRON NATIONAL GRASSLAND (KANSAS) AND THE COMANCHE NATIONAL GRASSLAND (COLORADO)

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ABSTRACT

We report the results of a floristic inventory conducted in southwestern Kansas and southeastern Colorado, an area that includes Cimarron National Grassland, Comanche National Grassland, and adjacent private lands. Our study area, spread over Baca, Las Animas, and Otero counties in Colorado and Morton County in Kansas, encompasses 567,300 acres. Results are enumerated in an annotated checklist, based on 9,281 numbered collections of vascular plants. A total of 635 unique taxa are documented from 87 families, including 80 exotics and 26 species of conservation concern. *Cyperus retroflexus* is reported as an addition to the flora of Kansas. Two state records are documented for Colorado: *Astrolepis integerrima* and *Digitaria pubiflora*.

RESUMEN

Se aportan los resultados de un inventario florístico realizado en el suroeste de Kansas y sureste de Colorado, un área que incluye el Cimarron National Grassland, Comanche National Grassland, y tierras adyacentes privadas. Nuestra área de estudio, se extiende por los condados de Baca, Las Animas, y Otero en Colorado y condado de Morton en Kansas, abarca 567,300 acres. Los resultados se enumeran en un catálogo anotado basado en 9,281 colecciones numeradas de plantas vasculares. Un total de 635 taxa únicos, se documentan de 87 familias, incluyendo 80 exóticas y 26 especies con interés de conservación. *Cyperus retroflexus* es una adición a la flora de Kansas. Se documentan dos citas estatales para Colorado: *Astrolepis integerrima* y *Digitaria pubiflora*.

INTRODUCTION

We report on a vascular plant inventory of Cimarron National Grassland (Cimarron) and Comanche National Grassland (Comanche), located in extreme southwestern Kansas and southeastern Colorado, respectively (Fig. 1). Included are private lands adjacent to the Comanche National Grassland.

The Cimarron consists of 108,175 acres located primarily in Morton County, Kansas, with a disjunct parcel of 480 acres in Stevens County. The Comanche, located in three Colorado counties (Baca, Las Animas, and Otero) encompasses 443,765 acres. Both Grasslands, together covering 551,940 acres, are managed by the USDA Forest Service. The private lands included in our study comprise 15,360 acres scattered throughout Las Animas and Otero counties. Thus, the total area, herein referred to as the Grasslands, covers 567,300 acres. Elevation ranges from about 3,200 feet to just over 6,400 feet.

The Grasslands are located in the Great Plains floristic region (Fenneman 1946). Comprehensive treatments that include this area are Rydberg (1932) and Great Plains Flora Association (1986). Although several state Floras cover Colorado, (Harrington 1954; Weber & Wittman 2001a; Weber & Wittman 2001b), only a few checklists and inventories exist for the area. These publications focus on areas near or within the Grasslands boundaries (Anderson 1950; Clark 1996; Freeman 1989; Hazlett 2004; Shaw et al. 1989; Weber & Wittman 1994).

This botanical inventory is part of the larger effort by the Rocky Mountain Herbarium (RM) to produce a critical flora of the Rocky Mountains and to map, based on vouchered specimens, the distributions of its taxa in relatively fine detail (Hartman 1992; Hartman & Nelson 2008; Hartman et al. 2009). To this end, 64 inven-

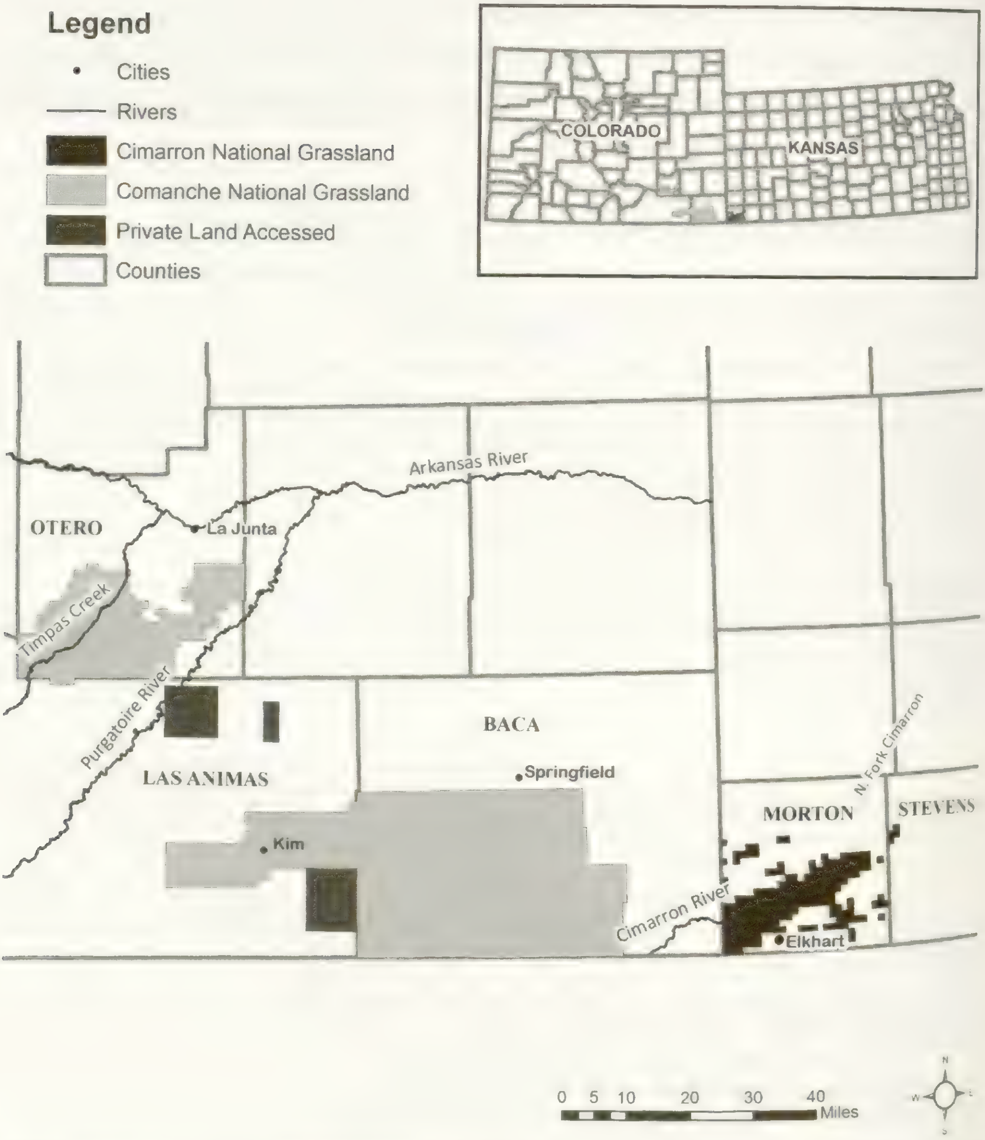

FIG. 1. The location of the Cimarron National Grassland and the Comanche National Grassland in extreme southwest Kansas and adjacent Colorado, respectively, and an enlargement of the area.

tories (48 as MS thesis projects) have been conducted. The Grasslands represent the easternmost project completed thus far.

Topography

The Cimarron and the Comanche are located in the Great Plains region of the United States. Within this region, two ecological subregions have been identified: Western High Plains and Southwest Tablelands (Omernik 1995). The Western High Plains, covering Baca and Morton counties, are characterized topographically as smooth to slightly irregular, with a high percentage of dryland agriculture (Chapman et al. 2001). Typical plant

communities are grasslands and shrublands. The Southwest Tablelands of Las Animas and Otero counties are characterized by red sandstone canyons, mesas, rock outcrops, and little arable land (Chapman et al. 2006). Here, shrublands and woodlands are the dominant plant communities.

The entire study area is located within the Arkansas River watershed. The Cimarron River traverses the southeastern corner of Baca County, then flows northeast through Morton and Stevens counties, Kansas (Fig. 1). The broad, gently east-sloping plains north of the Cimarron River, in Kansas, contain the lowest point at approximately 3,259 feet (Freeman 1989). The Cimarron River is often dry, with a sandy bed and subsurface water. The Purgatoire River flows northeast through the western unit of the Comanche, carving the Purgatoire River Canyon through sandstones on the plains, and ultimately emptying into the Arkansas River east of La Junta. The highest elevation (6,444 feet) is in the Mesa de Maya area, Las Animas County, near Tobe, Colorado.

Climate

The climate in the region is semiarid, as precipitation levels are influenced by the rain shadow of the Rocky Mountains, the effect of which weakens eastward. Thus, the Cimarron receives more annual precipitation than the Comanche. The Elkhart weather station near Cimarron National Grassland receives an average of 17.92 inches of precipitation annually, whereas La Junta and Springfield, both near Comanche National Grassland, average 15.29 and 16.03 inches, respectively (HPRCC 2010). Weather patterns are characterized by low relative humidity, abundant sunshine, infrequent precipitation, moderate to high winds, and high rates of evaporation (Doesken et al. 2003).

Mean high temperatures range from 70.8°F in La Junta to 65.5°F in Kim. The mean low temperatures are highest in Elkhart (41°F) and lowest in Kim (36°F).

Intense thunderstorms with violent winds and hail are not uncommon from mid April through October, when the majority of the annual precipitation falls (70–80%). Average annual precipitation from five weather stations in the area ranges from 14.89 to 17.92 inches (HPRCC 2010). During 2007, the first of the two field seasons, precipitation was categorized as extremely moist in southwestern Kansas, and near normal in southeastern Colorado (NCDC 2010). Snowstorms in December of 2006 deposited a record 45 inches of snow, resulting in lush vegetation during the 2007 collecting season. In 2008, levels were near normal in southwestern Kansas. However, extremely low precipitation levels were documented in southeastern Colorado, causing drought and frequent dust storms on the Comanche (Doesken 2009). Consequently, fewer species were documented during the second collecting season.

Geology

The Grasslands and vicinity can be divided into four major geologic areas: High Plains, Mesa de Maya, Purgatoire River, and Arkansas Valley. The High Plains stretch across the eastern portion of the area encircled by Elkhart, Kim and Springfield, and encompass a broad, rolling upland dissected by rivers and streams. During the Paleozoic and Mesozoic eras, little faulting occurred in the High Plains. The Laramide Orogeny (72 to 40 mya) that led to the uplift of the Rocky Mountains caused inland Cretaceous seas to retreat. Subsequently (late Cretaceous and Tertiary periods), rivers flowing eastward cut deep valleys and deposited alluvial materials that washed eastward forming the High Plains.

The Mesa de Maya region, like most of eastern Colorado, is composed of sedimentary formations laid down through the Paleozoic and Mesozoic eras (Chronic and Chronic 1972). However, Mesa de Maya, a mammoth plateau extending into southeastern Las Animas County from northern New Mexico, is the result of volcanic eruptions during the Pliocene (Clark 1996). Lava flows formed a hard basalt cap on the more erosive Ogallala Formation. The sedimentary formations eroded more quickly, resulting in irregularly-shaped networks of canyons (Clark 1996). The Morrison, Ralston Creek, and Entrada formations, all sedimentary strata of Jurassic Period, are exposed on the New Mexico border. The Chacuaco Creek drainage forms the western border of Mesa de Maya and displays some of the most complex geology in eastern Colorado. Cretaceous Dakota Sandstone is visible along the banks, and is overlain by the Carlile Shale, Greenhorn Limestone, and Graneros Shale. Above these strata rest the limestones and shales of the Niobrara Formation, followed by the Ogallala that is capped by basalt (Tweto 1979).

The Purgatoire River flows northeast between the two units of the Comanche, winding through a maze of canyons (Fig. 1). The lowest exposed strata, all Permian in age, are the Big Basin, Dry Creek, and White Horse formations (Lockley et al. 1997). During the Triassic Period, the red sandstones of the Chinle Formation were deposited. In Picketwire Canyon, Jurassic deposits are visible, including the Entrada Formation, the Ralston Creek/Bell Ranch Formation, and the Morrison Formation (Lockley et al. 1997). These Jurassic deposits contain the largest dinosaur trackway in North America. Later, during the Cretaceous, the area was submerged by a shallow sea that deposited Cretaceous strata that include the Purgatoire, Dakota Sandstone, Graneros Shale, Greenhorn Limestone, Carlile Shale, and Niobrara formations (chronologically). The Purgatoire Formation includes two members of the nearly white Lytle Sandstone and the Glencairn Sandstone and Marine Shales (Lockley et al. 1997). The fluvial sandstones and conglomerate of the Lytle Formation are indicative of fast-moving water. In contrast, the Glencairn Formation is a thin, brittle bed of marine sediments sandwiched between the Lytle and Dakota sandstones. Dakota sandstone of marine origin is readily recognizable, with its caramel and dark brown shades, and prominently lines the rims of the canyons that wind through the Purgatoire Valley. Graneros Shale, Greenhorn Limestone, Carlile Shale, and the Niobrara formations, all late Cretaceous, form the slopes and rounded hills above the canyon rim (Lockley et al. 1997).

The Arkansas River cuts a broad valley through eastern Colorado. Heavy use of water for irrigation has lowered the levels of the river considerably, but it remains the largest in southeastern Colorado. The river bed and floodplain are awash with alluvium, along with older Quaternary gravels. Rounded, undulating hills to the south rise up from the floodplain between Timpas Creek and the Purgatoire River. These hills are capped by late Cretaceous shale and limestone of the Niobrara Formation.

METHODS

Field work on the Cimarron National Grassland and the Comanche National Grassland was conducted during the summers of 2007 and 2008. A total of 134 days were spent collecting (May 25–Aug 27, 2007; May 12–Aug 1, 2008). An additional two days in April 2008 served to document early blooming species such as *Cymopterus acaulis* and *Leucocrinum montanum*. We returned in September to collect especially late blooming members of Poaceae and Asteraceae, among them *Schizachryium scoparium* and *Artemisia filifolia*, respectively.

We used the "meander search" strategy (Goff et al. 1982; Ristau 1998; Hartman 1992; Hartman & Nelson 2008). Thus, sites were not selected at random, but chosen to provide adequate geographic coverage. We also chose sites that captured the range of geologic substrates, soil types, and plant communities. This methodology allowed us to document a much greater diversity of taxa. Species of conservation concern and noxious weeds were a collecting priority.

At each collection site (431 total), a waypoint was taken using a GPS unit. Field notes were taken on the habitat, dominant plant species and landforms. Collecting took place within a one-half mile radius or less of each waypoint. All species present in flower or fruit were collected, placed in plastic bags, and stored in an ice chest. Plants were pressed at the Carrizo Work Center outside of Springfield, the Comanche National Grassland office in La Junta, and the Higbee Barn, 17 miles south of La Junta. Specimens were placed in folded sheets of newspaper, inserted between cardboards, and then secured in a plant press. The press was then placed on a drier for one to two days. Once dry, the specimens were bundled and transported to the RM. Other details regarding collecting are described in Hartman (1992) and Hartman and Nelson (2008); standard collecting protocol followed in all RM floristic studies. Nomenclature follows that adopted for the RM Plant Specimen Database (Hartman et al. 2009).

The Annotated Checklist is based on 9,281 collections from the Cimarron National Grassland, the Comanche National Grassland, and adjacent private lands. This includes 521 specimens collected by Brian Elliott in 2003 and 2004 from the Comanche. In 2008, we were permitted by land owners to collect on five ranches bordering the Comanche. These ranches offered sites with the most dramatic topographic relief: high flat grasslands on top of Black Mesa, deep canyons cut by Carrizo Creek, and red sandstone spires of Beatty Canyon.

All specimens are housed at RM. The specimen data were entered into the RM Plant Specimen Database and are available online (Hartman et al. 2009). Duplicates were sent to COLO, CS, and KANU herbaria.

RESULTS AND DISCUSSION

Results of the study are included in the following sections. Vegetation Types, Exotic Taxa and Noxious Weeds, Taxa of Conservation Concern, State Records, and Summary of Taxa.

VEGETATION TYPES

The vegetation on the Cimarron and the Comanche has been described by Freeman (1989), Hazlett (2004), and Shaw et al. (1989). Based on these classifications, we identified 11 vegetation types within five broad physiognomic categories. Each contains common associates and physical features such as climate and landform.

Grassland

Shortgrass prairie.—Shortgrass prairie is the most widespread vegetation type. It occupies the gentle hills and plains across Baca and Morton counties, at low elevations (3,200–4,500 feet). This true grassland community is dominated by warm-season grasses, with only scattered shrubs. The dominant grass species are *Aristida purpurea* var. *longiseta*, *Bouteloua gracilis*, *Buchloë dactyloides*, *Elymus smithii*, *Muhlenbergia torreyi*, *Sporobolus cryptandrus*. *Hilaria jamesii* (*Pleuraphis jamesii*) is the subdominant, often occurring in large patches. Two cacti are common: the shrubby *Cylindropuntia imbricata* and the low-growing *Opuntia polyacantha*. Tree cover is limited to scattered stands of *Juniperus monosperma*, with very limited occurrences of *Celtis reticulata*. Overstory species are *Ipomoea leptophylla* and *Yucca glauca*. Representative forbs include *Astragalus missouriensis* var. *missouriensis*, *Engelmannia pinnatifida*, *Erysimum asperum*, *Gutierrezia sarothrae*, *Lygodesmia juncea*, *Mirabilis linearis*, *Psoralidium tenuiflorum*, *Sphaeralcea coccinea*, *Stephanomeria pauciflora*, *Thelesperma megapotamicum*, and *Xanthisma spinulosum* var. *spinulosum*. This vegetation type on the Grasslands is typically managed as rangeland.

Midgrass Prairie.—Southwestern Baca County and southeastern Las Animas County contain patches of midgrass prairie that intergrade into Juniper woodland (see description below). Dominant grasses representative of tallgrass prairie elements include *Andropogon gerardii*, *Bothriochloa laguroides*, and *Bouteloua curtipendula*. Shortgrass prairie grass elements include *Bouteloua gracilis*, *B. hirsuta*, *Hilaria jamesii* (*Pleuraphis* jamesii), and *Hesperostipa comata*. Characteristic forbs include: *Asclepias latifolia*, *Liatris punctata*, *Ratibida columnifera*, *Solidago wrightii*, and *Thelesperma megapotamicum*. The most extensive patches of midgrass prairie can be found in Carrizo, Holt, and Picture canyons (Baca County). *Amorpha canescens*, *Mimosa quadrivalvis* var. *angustata* (*Mimosa nuttallii*), *Onosmodium molle*, and *Sorghastrum nutans* are sporadic in the canyons, and are also representative species of the tallgrass prairie. If grazing pressure is low, this vegetation type displays the richest floristic diversity.

Rocky Upland Prairie.—Rocky breaks and uplands of sandy and calcareous deposits occur throughout portions of Baca, Las Animas, Morton and Otero counties. Perhaps the most recognized example of the Rocky upland prairie within the Comanche National Grassland occurs approximately 20 miles south of La Junta. Here, the shale barrens that rise above the Purgatoire River Valley harbor a distinct plant community dominated by *Cryptantha thyrsiflora*, *Dalea purpurea*, *Dalea jamesii*, *Echinocereus reichenbachii*, *Eremogone hookeri*, *Eriogonum lachnogynum*, *Paronychia jamesii*, and *Tetraneuris acaulis*. This unique assemblage of forbs is interspersed with the grass species *Achnatherum hymenoides* and *Hesperostipa neomexicana*. Scattered *Juniperus monosperma* trees are present and *Rhus trilobata* var. *trilobata* and *Artemisia bigelovii* are the most common shrubs. Exotic species are uncommon due to low disturbance, harsh environmental conditions, and inaccessibility by cattle.

Shrublands

Sandsage Prairie.—Stabilized and active sand dunes occur over large expanses along the Cimarron River in Morton County, and near Campo in southeastern Baca County. Distinctive Sandsage prairie occupies dunes that lie in a band 1–5 miles wide, south of the river. Dense stands of *Artemisia filifolia*, *Ericameria nauseosa*, and *Yucca glauca* dominate the community. Typical forbs are *Abronia fragrans*, *Chenopodium pratericola*, *Mentzelia nuda*, *Oenothera lavandulifolia*, *Palafoxia rosea*, and *Polanisia dodecandra*. Grass species provide less plant cover

here, and include *Andropogon hallii*, *Calamovilfa gigantean*, *Elymus elymoides*, *Panicum capillare* var. *capillare*, *Schedonnardus paniculatus*, and *Sporobolus cryptandrus*.

Saline Bottom Shrubland.—Small stretches of this shrubland are restricted to alluvial fans along streams and arroyos. The Purgatoire River and Timpas Creek in Otero County host its most extensive coverage. The overstory is dominated by *Sarcobatus vermiculatus* and *Atriplex canescens*. The understory is comprised of the following grass species: *Distichlis spicata*, *Elymus smithii*, *Muhlenbergia arenacea*, and *Sporobolus airoides*. Forb cover is low, but commonly includes: *Gutierrezia sarothrae*, *Opuntia fragilis*, and *Plantago patagonica*.

Woodlands

Cottonwood Gallery Forest.—These forests occur in deep, sandy soils of alluvial fans along flood plains of the Purgatoire and Cimarron rivers. It is also present in small patches along smaller creeks and streams. The dominant tree species is *Populus deltoides* var. *occidentalis* (*Populus deltoides* ssp. *monolifera*), with occasional occurrences of *Salix amygdaloides*. Common shrubs are *Ericameria nauseosa* and *Salix exigua*. Thickets of the exotic shrub *Tamarix ramosissima* are present along these rivers. Understory forbs include *Croton texensis*, *Opuntia tortispina*, *Sphaeralcea coccinea*, and *Tradescantia occidentalis*. The exotic grass *Bromus japonicus* is often present along with the native species *Elymus elymoides*.

Juniper Woodland.—Juniper woodlands occur where more than 25 percent of the total cover consists of juniper (Schrupp et al. 2000). These woodlands are found in the southwestern portion of the Comanche, often on the Dakota Sandstone Formation. This is the most common vegetation type in the Southwest Tablelands Ecoregion (Chapman et al. 2001). *Juniperus monosperma* is often the dominant tree species: more infrequently *Juniperus scopulorum* is the co-dominant. The latter community, found in rock canyons and hillsides in the western portion of the study area, typically has an understory of *Cercocarpus montanus*, *Ptelea trifoliata*, *Rhus trilobata* var. *trilobata*, and *Ribes aureum*. The xeric-adapted ferns *Cheilanthes eatonii*, *C. fendleri*, and *Pellaea atropurpurea* occur in cracks of sandstone canyon walls, often on south-facing exposures. Forb associates frequently include *Asclepias asperula*, *Dalea purpurea*, *Eriogonum tenellum*, *Melampodium leucanthum*, *Mirabilis linearis*, and *Psoralidium tenuiflorum*. Common understory grasses are *Bouteloua curtipendula*, *B. eriopoda*, and *B. hirsuta*. Woodlands dominated by *Juniperus monosperma* typically exhibit widely spaced trees often interspersed with *Rhus trilobata* var. *trilobata*. Open, dry patches between trees often contain *Bouteloua* spp., *Melampodium leucanthum*, and *Mirabilis multiflora*.

Pinyon-Juniper Woodland.—Pinyon-juniper woodlands are restricted to the southwestern portion of the Comanche and adjacent private lands. The tree species *Juniperus monosperma*, *J. scopulorum*, and *Pinus edulis* dominate the overstory. Common shrubs are *Cercocarpus montanus*, *Quercus gambelii*, *Quercus* ×*undulata*, and *Rhus trilobata* var. *trilobata*. These woodlands were found in Baca, Otero, and Las Animas counties at elevations of 4,420 to 6,440 feet. In Baca County, it is restricted to three sites: southwest of Pritchett along East Carrizo Creek, Carrizo Canyon, and Big Hole Spring. In Otero County it is limited to Christian Canyon near Delhi, Colorado. Las Animas County contained the majority of sites with seven occurrences of pinyon-juniper woodland. Six vouchers of *Pinus ponderosa* were documented from these woodlands, all on private lands in Baca, Las Animas, and Otero counties, and represent the first occurrence in Otero County (USDA 2010). Common forbs found in this community type include *Castilleja integra*, *Echinocereus viridiflorus*, *Linum lewisii*, *Mirabilis multiflora*, and *Sophora nuttalliana* and the grasses *Bouteloua curtipendula*, *B. hirsuta*, and *Piptatherum micranthum*.

Riparian

Riparian areas are limited in the arid Grasslands. However, major rivers (Arkansas, Cimarron, and Purgatoire), creeks, springs, small ponds, and irrigation ditches provide water to the otherwise dry lands. The Plains cottonwood, *Populus deltoides* var. *occidentalis*, forms gallery forests in Morton County, but occurs in scattered populations or as lone individuals elsewhere in the Grasslands (see description of Cottonwood gallery forest). *Salix exigua* is common across all five counties. *Typha* spp., *Tamarix ramosissima*, *Schoenoplectus pungens*, and *Calamovilfa gigantea* are found on the banks of major rivers and creeks. Small pools and ponds commonly host

Lemna minor and the following forbs: *Ranunculus scleratus, Rumex crispus*, and *Veronica anagallis-aquatilis*. Grasses include: *Distichlis spicata, Echinochloa muricata*, and *Polypogon monspeliensis*. *Eleocharis macrostachya, Equisetum laevigatum*, and *Juncus torreyi* may line edges of both standing and moving water.

Disturbed

Stock Pond.—Excavated areas that serve to collect water for livestock are scattered throughout the Grasslands. Water levels fluctuate drastically throughout the season. Typical forbs that subsist on the muddy margins are *Atriplex argentea, Iva axillaris, Polygonum aviculare, Rorippa sinuata*, and *Xanthium strumarium*. The grass species *Polypogon monspeliensis* is also frequent on the banks, along with the exotic *Eragrostis cilianensis*. The cattail *Typha domingensis* was documented at ten of these sites.

Roadside.—This vegetation type often harbors more plant diversity than surrounding rangeland, especially during periods of drought. The combination of disturbance from road maintenance activities along with the exclusion of cattle by fences allows a mix of native species, along with exotic and weedy agricultural taxa, to thrive. With the absence of grazing pressure, native species often persist along a road margin yet are absent in an adjacent rangelands. For example, a rocky roadcut may contain members of the Rocky Upland Prairie such as *Dalea purpurea* and *Tetraneuris acaulis*, but a careful search reveals none of these species on the other side of a cattle fence. Common native grasses are *Cenchrus longispinus, Chloris verticillata, Elymus elymoides, Elymus smithii*, and *Hordeum pusillum*. Exotic grass species such as *Aegilops cylindrica, Bromus japonicus*, and *B. tectorum* are frequent. Forbs include *Convolvulus arvensis, Cucurbita foetidissima, Quincula lobata, Tragopogon dubius, Tribulus terrestris*, and *Verbena bracteata*. Weedy species of *Ambrosia, Chamaesyce, Cirsium, Melilotus, Physalis*, and *Solanum* are also common.

EXOTIC TAXA AND NOXIOUS WEEDS

National Grasslands managed as rangeland have a high percentage of exotic taxa. Percentages from studies on several regional National Grasslands are as follows: Buffalo Gap (17.1%), Kiowa and Rita Blanca (11%), Ogallala (14.9%), Pawnee (22%), and Thunder Basin (16.3%) (Ebertowski 2005; Hazlett 1998; Hazlett et al. 2009; Kostel 2006). We documented 80 exotic taxa, comprising 12.6 percent of the species in the annotated checklist. The Colorado noxious weed list contains 68 plant species, 16 of which were collected in this study (CDA 2010). They are *Aegilops cylindrica, Arctium minus, Bromus tectorum, Cirsium vulgare, Convolvulus arvensis, Cynoglossum officinale, Dipsacum fullonum, Elaeagnus angustifolia, Erodium cicutarium, Hibiscus trionum, Linaria dalmatica, Sonchus arvensis, Sorghum halapense, Tamarix ramosissima, Tribulus terrestris*, and *Verbascum thapsus*. Of the 12 noxious weeds so designated for Kansas, three were documented in that state: *Convolvulus arvensis, Hoffmannsegia glauca*, and *Sorghum halapense*. The following Colorado noxious weeds were documented in Kansas where they are not so recognized: *Bromus tectorum, Elaeagnus angustifolia, Erodium cicutarium, Tamarix ramosissima*, and *Tribulus terrestris*.

TAXA OF CONSERVATION CONCERN

A total of 26 taxa of conservation concern were documented from 72 sites on the Grasslands and adjacent private lands. No federally listed plant species were documented (USFW 2010), nor are any known from the area. Taxa of conservation concern are those tracked by the Colorado Natural Heritage Program and the Kansas Natural Heritage Program, or listed as Sensitive by the U.S. Forest Service (CNHP 2011; KNHP 2011; USFS 2011). These taxa are listed alphabetically below, followed by family name, counties of occurrence, and voucher (collector surname and collection number). County name and voucher citation are listed only for taxa of conservation concern status as recognized in Kansas versus Colorado.

Achnatherum hymenoides (Poaceae) Morton: *Nelson 72121.*

Argythamnia humilus (Euphorbiaceae) Otero: *Kuhn 2708.*

Asclepias involucrata (Apocynaceae) Baca: *Kuhn 561.*

Asclepias macrotis (Apocynaceae) Las Animas: *Kuhn 3573, 5426, 7575.*

Asclepias oenotheroides (Apocynaceae) Las Animas: *Kuhn 6946.*

Asplenium platyneuron (Apocynaceae) Baca, Otero: *Elliott 12036; Kuhn 6859; Nelson 72560.*

Berlandiera lyrata (Asteraceae) Morton: *Elliott 11996; Kuhn 760, 3958, 6563, 7131; Nelson 71851, 71909, 72154, 72428.*

Bothriochloa springfieldii (Poaceae) Baca, Las Animas, Otero: *Kuhn 3578, 3616, 6681; Nelson 72472.*

Cheilanthes eatonii (Pteridaceae) Baca, Las Animas, Otero: *Elliott 12042b; Kuhn 1494, 2919, 3786, 3787, 3801, 3811, 3863, 3864, 4347, 6982.*

Cuscuta umbellata (Convolvulaceae) Hamilton: *Kuhn 2827.*

Dalea cylindriceps (Fabaceae) Morton: *Kuhn 2268; Nelson 72053.*

Dalea jamesii (Fabaceae) Morton: *Kuhn 5988; Nelson 72164.*

Eleocharis rostellata (Cyperaceae) Morton: *Kuhn 1107.*

Frasera coloradensis (Gentianaceae) Baca: *Kuhn 1902.*

Lobelia cardinalis (Campanulaceae) Baca: *Elliott 12026.*

Oenothera engelmannii (Onagraceae) Morton: *Kuhn 1056, 1119, 1135.*

Oenothera harringtonii (Onagraceae) Otero: *Kuhn 1331, 2762, 3105, 3310; Nelson 72495, 72555.*

Pellaea atropurpurea (Pteridaceae) Baca, Las Animas: *Elliott 11977; Kuhn 1506, 3775, 3873, 3874, 5799, 6981.*

Pellaea wrightiana (Pteridaceae) Baca: *Nelson 72562.*

Penstemon jamesii (Plantaginaceae) Baca, Las Animas: *Hartman 84838, 85020; Kuhn 766.*

Picradeniopsis oppositifolia (Asteraceae) Morton: *Kuhn 5918.*

Prunus angustifolia (Rosaceae) Baca, Las Animas, Otero: *Kuhn 3930, 5193, 6816, 7190.*

Sphaeralcea angustifolia (Malvaceae) Morton: *Kuhn 1183, 3981.*

Teucrium laciniatum (Lamiaceae) Morton: *Nelson 72052.*

Vernonia marginata (Asteraceae) Morton: *Kuhn 7404.*

Woodsia neomexicana (Dryopteridaceae) Baca and Otero: *Kuhn 3794, 4364, 5800, 7799, 7826.*

STATE RECORDS

We report two taxa new to the flora of Colorado: *Astrolepis integerrima* and *Digitaria pubiflora* (Weber and Wittman 2001b; USDA 2010; FNA 1993+). *Cyperus retroflexus* is reported here as an addition to the flora of Kansas (Freeman 2005).

Astrolepis integerrima, a xeric-adapted silver cloak fern, is known from Arizona, New Mexico, Oklahoma, and Texas (FNA 1993+). It was previously reported as a state record for Colorado by Clark (1996), but the specimen was subsequently annotated as *Astrolepis cochisensis* by Ranker and Orthner in 2000. Thus, our voucher from Baca County serves as the first collection from Colorado, and represents the northern geographic limit of the taxon. The voucher was collected in Sand Canyon, from shaded cracks in the sandstone canyon walls.

COLORADO. Baca Co.: Comanche National Grassland, Sand Canyon, ca. 25 air mi S of Pritchett; 37.0178°N, 102.8367°W, along sandstone cliffs with *Juniperus monosperma* and *Rhus aromatica*, 4,367 ft, 19 Apr 2008, *Kuhn 3778 with E. Elliott and B. Elliott* (RM).

Digitaria pubiflora, a crabgrass, is known from Arizona, New Mexico, Oklahoma, and Texas. Our two collections, from weedy, sandy roadsides in Baca County, represent its northern geographic limit.

COLORADO. Baca Co.: Comanche National Grassland, Picture Canyon, ca. 29 air mi SSW of Springfield, 37.0073°N, 102.7486°W, along *Salix*-dominated wet seep; shortgrass prairie with *Yucca* sp., *Opuntia* sp., and *Buchloë dactyloides*; grazed, 4,225 ft, 7 Jun 2007, *Kuhn 862* (RM); side canyon of Holt Canyon, ca 1.5 air mi N of Oklahoma, ca 12 air mi SW of Campo, 37.0237°N, 102.7798°W, lower slopes and bottom of narrow side canyon with hackberry and soapberry, 4,320–4,400 ft, 21 Jun 2007, *Nelson 72475* with *Kuhn* (RM); det. Kelly W. Allred.

Cyperus retroflexus, collected on the Cimarron National Grassland, is an addition to the flora of Kansas. Our voucher, collected from rolling sand dunes along the Cimarron River, represents the northern geographic

limit for the taxon. It has been documented in Alabama, Arizona, Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas.

KANSAS. Morton Co.: Cimarron National Grassland, along Cimarron River and Turkey Trail ca. 1 air mi E of KS Hwy 27, ca. 8.5 air mi N of Elkhart, 37.1233°N, 101.882°W to 37.1262°N, 101.8825°W, low sand dunes in the river bottom, with scattered cottonwoods, 3,375 ft, 18 Sep, *Nelson 72034* (RM).

SUMMARY OF TAXA

List by taxon	List by special category	Major group
Families (87)	CO Noxious Weeds (16)	Ferns (11)
Genera (346)	KS Noxious Weeds (3)	Fern Allies (5)
Species (603)	Exotic Taxa (80)	Gymnosperms (5)
Hybrids (6)	CO Endemics (1)	Angiosperms (614)
Infraspecies (26)	KS Endemics (0)	
Unique Taxa (635)	Conserv. Concern (26)	

635 unique taxa, 603 species, 87 families

CONCLUSION

This paper presents the results of the first floristic inventory based on vouchered specimens that encompasses the Cimarron National Grassland, the Comanche National Grassland, and adjacent private lands. We report on results of 9,281 numbered collections of vascular plants collected over 567,300 acres. A total of 635 unique taxa representing 87 families were documented. Of these, 80 are exotic taxa of which 16 are designated as noxious weeds by Colorado; 3 by Kansas. We documented 26 species of conservation concern, 2 additions to the flora of Colorado, and 1 addition to the flora of Kansas.

ANNOTATED CHECKLIST

The checklist is divided into the major groups of vascular plant (fern allies, ferns, gymnosperms, and angiosperms) each with alphabetical listings by family and species. Nomenclature follows that adopted for the RM Plant Specimen Database (Hartman et al. 2009).

Following is a guide to format and abbreviations associated with individual taxa in the checklist. Collection data are available online at http:/www.rmh.uwyo.edu (Hartman et al. 2009).

Taxon Authority **(number of collections)**; COUNTY; elevational range in feet; vegetation type.

County:

Colorado= BA (Baca), LA (Las Animas), OT (Otero)
Kansas= MO (Morton)

Vegetation type:

cgf	Cottonwood gallery forest	**jw**	Juniper woodland
mgp	Midgrass prairie	**pjw**	Pinyon juniper woodland
rip	Riparian	**rd**	Roadside
rup	Rocky upland prairie	**sbs**	Saline bottom shrubland
sgp	Shortgrass prairie	**ssp**	Sandsage prairie
stp	Stockpond		

Symbols by category proceeding Taxon:
○ Taxon of Conservation Concern, Colorado
● Taxon of Conservation Concern, Kansas
■ Introduced from outside North America
× Hybrid
! State record

FERN ALLIES

Equisetaceae

×*Equisetum ×ferrissii* Clute **(1)** OT; 4240′; rip

Equisetum arvense L. **(1)** OT; 4160′; rip

Equisetum laevigatum A. Braun **(7)** BA, LA, MO; 3410–6090′; rip

Equisetum variegatum Schleich. ex F. Weber & D. Mohr var. *variegatum* **(4)** BA, LA; 4300–5100′; rip

Selaginellaceae

Selaginella densa Rydb. **(16)** BA, LA, OT; 4250–5140′; jw, mpg, pjw, sgp, ssp

FERNS

Aspleniaceae

○ *Asplenium platyneuron* (L.) Britton, Sterns, & Poggenb. **(3)** BA, OT; 4300–4930′; mgp, rip

Asplenium trichomanes L. **(1)** OT; 4930–4930′; rip

Dryopteridaceae

Cystopteris fragilis (L.) Bernh. **(2)** LA; 5530–5530′; pjw, rip

○ *Woodsia neomexicana* Windham **(5)** BA, OT; 4260–4930′; jw, mgp, rip

Woodsia scopulina D. C. Eaton **(1)** BA; 4300–4300′; mgp

Marsileaceae

Marsilea vestita Hook. & Grev. **(3)** LA, OT; 4760–5740′; rip

Pteridaceae

! *Astrolepis integerrima* (Hook.) D.M. Benham & Windham **(1)** BA; 4370–4370′; jw

○ *Cheilanthes eatonii* Baker **(11)** BA, LA, OT; 4250–5140′; jw, mgp, pjw, rip

Cheilanthes feei T. Moore **(15)** BA, LA, OT; 4150–6440′; jw, mgp, pjw, rup

○ *Pellaea atropurpurea* (L.) Link **(7)** BA, LA; 4250–5140′; jw, mgp, pjw

○ *Pellaea wrightiana* Hook. **(1)** BA; 4340–4400′; mgp

GYMNOSPERMS

Cupressaceae

Juniperus monosperma (Engelm.) Sarg. **(96)** BA, LA, MO, OT; 3540–6210′; mgp, pjw, rd, rup, sgp

Juniperus scopulorum Sarg. **(26)** BA, LA, MO; 3410–6440′; mgp, pjw, rd, rup, sgp

Juniperus virginiana L. **(11)** BA, LA, MO, OT; 3410–5560′; mgp, pjw, rd, sgp

Pinaceae

Pinus edulis Engelm. **(19)** BA, LA, OT; 4420–6440′; pjw

Pinus ponderosa C. Lawson & P. Lawson **(7)** BA, LA, OT; 4620–6080′; jw, pjw, sgp

ANGIOSPERMS

Adoxaceae

Sambucus nigra L. ssp. *cerulea* (Raf.) R. Bolli **(7)** LA, OT; 4230–6090′; rip, rd, sgp

Aizoaceae

Sesuvium verrucosum Raf. **(1)** OT; 4150–4150′; stp

Agavaceae

Yucca glauca Nutt. **(63)** BA, LA, MO, OT; 3290–5980′; jw, mgp, pjw, rd, rup, sgp, ssp

Alismataceae

Alisma gramineum Lej. (1) LA; 5040–5040′; rip

Sagittaria brevirostra Mackenzie & Bush (1) BA; 4250–4250′; rip

Sagittaria cuneata E. Sheld. (1) LA; 5860–5860′; rip

Sagittaria latifolia Willd. **(1)** OT; 4800–4800′; rip

Alliaceae [traditionally Liliaceae]

Allium textile A. Nelson & J.F. Macbr. **(8)** BA, LA, MO, OT; 3490–6440′; mgp, rup, sgp

Amaranthaceae [including Chenopodiaceae]

Amaranthus albus L. **(3)** BA, OT; 3970–4400′; rd

Amaranthus arenicola I.M. Johnst. **(10)** BA, MO; 3300–4490′; rd, sgp, ssp

Amaranthus blitoides S. Watson **(22)** BA, LA, MO, OT; 3440–6130′; jw, mgp, rd, sgp, ssp

Amaranthus palmeri S. Watson **(12)** BA, LA, OT; 4300–5860′; mgp, rd, rup, sgp

Amaranthus powellii S. Watson **(2)** LA, OT; 4940–5940′; rd, sgp

Atriplex argentea Nutt. var. *argentea* **(7)** OT; 4540–4940′; rup, sgp

Atriplex canescens (Pursh) Nutt. var. *canescens* **(36)** LA, MO, OT; 3430–6210′; jw, mgp, rup, sbs, sgp

Chenopodium album L. **(5)** BA, LA; 4250–5860′; mgp, sgp

■ *Chenopodium berlandieri* Moq. var. *zschackei* (Murr) Murr ex Asch. **(7)** BA, MO, OT; 3330–4830′; rip, rd, sgp, ssp, stp

Chenopodium fremontii S. Watson **(9)** LA, OT; 4300–6210′; jw, pjw

■ *Chenopodium glaucum* L. **(1)** LA; 6030–6030′; stp

Chenopodium incanum (S. Watson) A. Heller var. *incanum* **(15)** BA, LA, OT; 4050–5900′; jw, mgp, rd, sgp

Chenopodium pratericola Rydb. **(28)** BA, LA, MO, OT; 3310–5360′; cgf, jw, mgp, rd, rup, sgp, ssp

Chenopodium simplex (Torr.) Raf. **(1)** LA; 4500–4500′; rip

Chenopodium subglabrum (S. Watson) A. Nelson **(16)** LA, OT; 4220–6060′; jw, mgp, pjw, rup, ssp

Cycloloma atriplicifolium (Spreng.) J.M. Coult. **(4)** BA, MO; 3330–4460′; rd, ssp

Froelichia floridana (Nutt.) Moq. **(1)** LA; 4970–4970′; pjw

Froelichia gracilis (Hook.) Moq. **(4)** BA, MO; 3380–4490′; rup, sgp, ssp

■ *Kochia scoparia* (L.) Schrad. **(13)** BA, LA, OT; 4220–6130′; jw, rd, sgp, stp

Krascheninnikovia lanata (Pursh) A. Meeuse & A. Smit **(13)** LA, OT; 4210–6060′; pjw, rup, sgp

Monolepis nuttalliana (Schult.) Greene **(3)** MO, OT; 3660–4800′; mgp, sgp, stp

■ *Salsola collina* Pall. **(4)** OT; 4330–5100′; jw, rd, sgp

■ *Salsola tragus* L. **(37)** BA, LA, MO, OT; 3270–6130′; mgp, pjw, rd, rup, sgp, ssp, stp

Suckleya suckleyana (Torr.) Rydb. **(2)** OT; 4340–4500′; rip, stp

Tidestromia lanuginosa (Nutt.) Standl. **(1)** OT; 4350–4350′; jw

Anacardiaceae

Rhus trilobata Nutt. var. *trilobata* **(60)** BA, LA, MO, OT; 3410–6090′; jw, mgp, pjw, rup, sgp

Toxicodendron rydbergii (Small ex Rydb.) Greene **(4)** BA; 4150–4440′; jw, mgp, rip

Apiaceae

Berula erecta (Huds.) Coville var. *incisa* (Torr.) Cronquist **(4)** LA; 4560–5370′; rip

Cymopterus acaulis (Pursh) Raf. **(15)** BA, LA, OT; 4370–5980′; jw, mgp, pjw, rup, sgp

Cymopterus montanus Torr & A. Gray **(12)** BA, LA, OT; 4400–5980′; jw, mgp, rup, sgp

Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose var. *foeniculaceum* **(2)** LA; 5990–6050′; pjw

Apocynaceae [including Asclepiadaceae]

Apocynum cannabinum L. **(7)** MO, OT; 3350–4240′; cgf, rip, ssp

Asclepias arenaria Torr. **(7)** BA, MO, OT; 3370–4750′; cgf, rup, ssp

Asclepias asperula (Decne.) Woodson var. *asperula* **(8)** BA, LA, OT; 4290–5370′; jw, pjw, rup

Asclepias engelmanniana Woodson **(20)** BA, LA, MO, OT; 3420–5900′; jw, mgp, rup, sgp, ssp

○*Asclepias involucrata* Engelm. ex Torr. **(3)** BA, LA; 5000–5560′; sgp

Asclepias latifolia (Torr.) Raf. **(45)** BA, LA, MO, OT; 3360–6060′; jw, mgp, pjw, rd, rup, sgp, ssp

○*Asclepias macrotis* Torr. **(3)** LA; 4370–4820′; jw, rup

○*Asclepias oenotheroides* Cham. & Schltdl. **(1)** LA; 5100–5100′; pjw

Asclepias pumila (A. Gray) Vail **(2)** BA, LA; 4760–5600′; pjw, sgp

Asclepias speciosa Torr. **(5)** LA, MO, OT; 3410–6090′; rip

Asclepias subverticillata (A. Gray) Vail **(19)** BA, LA, MO, OT; 3620–6090′; mgp, pjw, rip, sgp, ssp

Asclepias tuberosa L. var. *interior* (Woodson) Shinners **(1)** LA; 6080–6080′; pjw

Asclepias viridiflora Raf. **(15)** BA, MO, OT; 3430–4980′; jw, mgp, pjw, rup, sgp, ssp

Araceae

Lemna minor L. **(4)** BA, LA; 4800–5100′; rip

Lemna turionifera Landolt **(5)** BA, LA; 4250–5110′; rip

Asteraceae

Agoseris parviflora (Nutt.) D. Dietrich **(1)** MO; 3420–3420′; sgp

Ambrosia confertiflora DC. **(5)** LA, OT; 4220–5770′; jw, rup, sgp

Ambrosia psilostachya DC. **(26)** BA, LA, MO, OT; 3330–5770′; mgp, pjw, rd, sgp, ssp

■*Arctium minus* Bernh. **(2)** LA; 5450–5960′; jw, rd

Artemisia biennis Willd. var. *biennis* **(2)** OT; 4160–4250′; sgp

Artemisia bigelovii A. Gray **(16)** LA, OT; 4330–4990′; jw, mgp, rup, sgp

Artemisia campestris L. var. *caudata* (Michx.) Palmer & Steyerm. **(1)** OT; 5140–5140′; pjw

Artemisia carruthii A.W. Wood ex Carruth **(2)** BA, LA; 4600–5420′; sgp

Artemisia dracunculus L. **(1)** OT; 4930–4930′; rd

Artemisia filifolia Torr. **(6)** BA, LA, OT; 4300–4910′; mgp, sgp, ssp

Artemisia frigida Willd. **(1)** LA; 5860–5860′; sgp

Artemisia ludoviciana Nutt. var. *albula* (Wooton) Shinners **(4)** LA, OT; 4220–4930′; jw

Artemisia ludoviciana Nutt. var. *ludoviciana* **(4)** BA, LA, OT; 4300–4930′; jw, mgp

Artemisia ludoviciana Nutt. var. *mexicana* (Willd. ex Spreng.) A. Gray **(1)** OT; 4800–4800′; rup

Baccharis salicina Torr. & A. Gray **(1)** MO; 3470–3470′; rip

Baccharis wrightii A. Gray **(2)** OT; 4860–4930′; pjw, sgp

●*Berlandiera lyrata* Benth. **(9)** BA, MO; 3430–4860′; jw, mgp, pjw, rup, sgp

Brickellia brachyphylla (A. Gray) A. Gray **(1)** OT; 5100–5100′; jw

Brickellia californica (Torr. & A. Gray) A. Gray **(5)** BA, LA, OT; 4300–4930′; jw, mgp

Brickellia eupatorioides (L.) Shinners var. *corymbulosa* (Torr. & A. Gray) Shinners **(4)** OT; 4590–5100′; rup, sgp

Chaetopappa ericoides (Torr.) G.L. Nesom **(48)** BA, LA, MO, OT; 3420–6030′; jw, mgp, pjw, rd, rup, sgp, ssp

Cirsium ochrocentrum A. Gray **(23)** BA, LA, MO; 3350–5960′; mgp, rd, rup, sgp, ssp

Cirsium undulatum (Nutt.) Spreng. **(30)** BA, LA, MO, OT; 3640–5900′; mgp, pjw, rd, rup, sgp, ssp

■*Cirsium vulgare* (Savi) Ten. **(1)** BA; 4250–4250′; rd

Conyza canadensis (L.) Cronquist **(25)** BA, LA, OT; 4050–6060′; jw, mgp, pjw, rd, rup, sgp, ssp, stp

Cyclachaena xanthifolia (Nutt.) Fresen. **(4)** BA, LA, OT; 4300–5860′; mgp, rd, sgp, stp

Diaperia prolifera (Nutt. ex DC.) Nutt. **(7)** BA, OT; 4080–4770′; mgp, pjw, sgp, ssp

Dyssodia papposa (Vent.) Hitchc. **(10)** LA, MO, OT; 3430–6210′; jw, rd, rup, sgp

Echinacea angustifolia DC. **(2)** BA; 4820–4980′; jw, mgp

Engelmannia pinnatifida A. Gray ex Nutt. **(54)** BA, LA, MO; 3200–5430′; jw, mgp, rd, rup, sgp, ssp

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G. I. Baird var. *graveolens* (Nutt.) Reveal & Schuyler **(1)** BA; 4750–4750′; rip

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G. I. Baird var. *nauseosa* **(6)** BA, LA, OT; 4340–5770′; jw, rip, rd, sbs, sgp

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G. I. Baird var. *oreophila* (A. Nelson) G.L. Nesom & G. I. Baird **(4)** BA, LA; 4410–5860′; rip, rd, sbs, sgp

Erigeron bellidiastrum Nutt. var. *bellidiastrum* **(21)** BA, MO, OT; 3290–4910′; cgf, mgp, rup, sgp, ssp

Erigeron bellidiastrum Nutt. var. *robustus* Cronquist **(10)** BA, LA, MO; 3360–4780′; cgf, jw, sgp, ssp

Erigeron concinnus (Hook. & Arn.) Torr. & A. Gray var. *subglaber* (Cronquist) G.L. Nesom **(1)** LA; 5560–5560′; sgp

Erigeron divergens Torr. & A. Gray **(37)** BA, LA, MO, OT; 3530–6130′; mgp, pjw, rd, rup, sgp

Erigeron pumilus Nutt. var. *pumilus* (Cronquist) Cronquist **(3)** LA; 5110–5230′; pjw, sgp

Gaillardia aristata Pursh **(1)**; BA, 4166′; sgp

Gaillardia pinnatifida Torr. **(26)** BA, LA, MO, OT; 3660–5980′; mgp, pjw, rd, rup, sgp

Gaillardia pulchella Foug. **(24)** BA, MO; 3290–4610′; jw, mgp, rup, sgp, ssp

Grindelia inornata Greene var. *inornata* **(19)** BA, LA, OT; 3200–5680′; mgp, pjw, rd, sgp, ssp

Grindelia squarrosa (Pursh) Dunal **(18)** BA, LA, OT; 4240–5940′; jw, mgp, rd, rup, sgp, stp

Gutierrezia sarothrae (Pursh) Britton & Rusby **(31)** BA, LA, OT; 4220–6210′; jw, mgp, rd, rup, sgp

Helianthus annuus L. **(60)** BA, LA, MO, OT; 3270–6210′; cgf, jw, pjw, rd, rup, sgp, ssp, stp

Helianthus ciliaris DC. **(1)** MO; 3580–3580′; sgp

Helianthus petiolaris Nutt. var. *petiolaris* **(36)** BA, LA, OT; 3350–5680′; cgf, mgp, pjw, rd, rup, sgp, ssp, stp

× *Helianthus petiolaris* Nutt. × *Helianthus annuus* L. **(4)** MO, OT; 3660–4820′; rd, rup, sgp

Heliomeris multiflora Nutt. var. *nevadensis* (A. Nelson) W.F. Yates **(1)** LA; 6060–6060′; pjw

Heterotheca horrida (Rydb.) V.L. Harms **(24)** BA, LA, OT; 3970–6060′; mgp, pjw, rup, sgp, ssp

Heterotheca subaxillaris (Lam.) Britton & Rusby **(2)** BA; 4300–4300′; mgp

Heterotheca villosa (Pursh) Shinners var. *villosa* **(19)** BA, LA, OT; 4230–5140′; jw, mgp, pjw, rup, sgp, ssp

Hymenopappus filifolius Hook. var. *cinereus* (Rydb.) I.M. Johnst **(8)** OT; 4370–4800′; mgp, rup, sgp

Hymenopappus filifolius Hook. var. *polycephalus* (Osterh.) B.L. Turner **(3)** BA, OT; 4400–4760′; rup, sgp

Hymenopappus flavescens A. Gray var. *flavescens* **(35)** BA, LA, MO; 3290–5180′; cgf, mgp, rd, rup, sgp, ssp

Hymenopappus tenuifolius Pursh **(37)** BA, LA, MO, OT; 3200–5980′; jw, mgp, pjw, rup, sgp, ssp

Hymenoxys odorata DC. **(6)** OT; 4290–4780′; mgp, pjw, rup, sgp

Iva axillaris Pursh **(9)** LA, OT; 4300–6030′; rip, rd, rup, sgp, stp

■*Lactuca serriola* L. **(19)** BA, LA, OT; 4220–6210′; jw, mgp, rip, rd, rup, sgp

Liatris punctata Hook. **(21)** BA, LA, OT; 4220–6210′; jw, mgp, rup, sgp

Lygodesmia juncea (Pursh) D. Don ex Hook. **(40)** BA, LA, MO, OT; 3290–5600′; jw, mgp, rd, rup, sgp, ssp

Machaeranthera tanacetifolia (Kunth) Nees **(26)** BA, LA, OT; 3200–5190′; mgp, rup, sgp, ssp

Melampodium leucanthum Torr. & A. Gray **(76)** BA, LA, MO, OT; 3290–5560′; jw, mgp, pjw, rup, sgp, ssp

Mulgedium pulchellum (Pursh) G. Don **(2)** OT; 4160–4210′; rd, rip
Nothocalais cuspidata (Pursh) Greene **(4)** LA, OT; 4560–5230′; jw, rd, rup, sgp
Oönopsis foliosa (A. Gray) Greene var. *foliosa* **(43)** LA, OT; 4200–6130′; jw, mgp, rd, rup, sgp
Packera plattensis (Nutt.) W.A. Weber & Á. Löve **(1)** BA; 4720–4720′; sgp
Packera tridenticulata (Rydb.) W.A. Weber & Á. Löve **(27)** BA, LA, OT; 4170–5980′; mgp, pjw, rup, sgp
Palafoxia rosea (Bush) Cory **(17)** BA, LA, OT; 4220–4940′; pjw, rd, rup, sgp, ssp
Palafoxia sphacelata (Nutt ex Torr.) Cory **(8)** BA, LA, MO, OT; 3380–4820′; cgf, jw, mgp, rup, sgp, ssp
Pectis angustifolia Torr. **(2)** BA, OT; 4240–4360′; jw, sgp
Pericome caudata A. Gray **(1)** BA; 4300–4300′; mgp
● *Picradeniopsis oppositifolia* (Nutt.) Rydb. ex Britton **(38)** BA, LA, MO, OT; 3360–6030′; jw, rd, rup, sgp, ssp
Picradeniopsis woodhousei (A. Gray) Rydb. **(5)** BA; 3870–4830′; sgp, ssp
Pseudognaphalium canescens (DC.) Anderb. **(2)** BA, LA; 4300–5120′; mgp
Ratibida columnifera (Nutt.) Wooton & Standl. **(78)** BA, LA, MO, OT; 3200–6080′; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Ratibida tagetes (E. James) Barnhart **(83)** BA, LA, MO, OT; 3360–6130′; jw, mgp, pjw, rd, rup, sgp, ssp
■ *Scorzonera laciniata* L. **(11)** BA, LA, OT; 4250–5720′; pjw, rd, rup, sgp
Senecio flaccidus Less. var. *douglasii* (DC.) B.L. Turner & T.M. Barkley **(24)** BA, LA, MO, OT; 3580–6060′; jw, mgp, pjw, rup, sgp
Senecio spartioides Torr. & A. Gray **(7)** BA, LA, OT; 4300–5770′; jw, mgp, rd, sgp
Solidago gigantea Aiton **(2)** BA, MO; 3550–4300′; mgp
Solidago missouriensis Nutt. **(1)** BA; 4300–4300′; mgp
Solidago mollis Bartl. **(4)** LA, OT; 4310–6060′; pjw, ssp
Solidago nana Nutt. **(1)** BA; 4760–4760′; rup
Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) E.J. Palmer & Steyerm. **(1)** OT; 4930–4930′; sgp
Solidago wrightii A. Gray **(6)** BA, LA, OT; 4300–5100′; jw, mgp, rup, sgp
■ *Sonchus arvensis* L. **(4)** LA, OT; 4220–5370′; rd, rip
■ *Sonchus asper* (L.) Hill **(3)** BA, LA, OT; 4250–4480′; rd
Stephanomeria pauciflora (Torr.) A. Nelson **(44)** BA, LA, MO, OT; 3360–6030′; mgp, pjw, rd, rup, sgp, ssp
Symphyotrichum ericoides (L.) G.L. Nesom var. *pansum* (S.F. Blake) G.L. Nesom **(1)** LA; 4410–4410′; rd
Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *commutatum* (Torr. & A. Gray) G.L. Nesom **(11)** BA, LA, OT; 4300–5770′; jw, rd, sgp
■ *Taraxacum officinale* Weber ex F.H. Wigg. **(10)** BA, LA, MO, OT; 3410–5960′; cgf, pjw, rd, sgp
Tetraneuris acaulis (Pursh) Greene var. *acaulis* **(51)** BA, LA, MO, OT; 3430–6050′; jw, mgp, pjw, rup, sgp
Tetraneuris scaposa (DC.) Greene var. *scaposa* **(5)** BA, MO; 3480–4770′; pjw, rup, ssp
Thelesperma filifolium (Hook.) A. Gray **(15)** BA, MO; 3290–4610′; jw, mgp, rd, rup, sgp, ssp
Thelesperma megapotamicum (Spreng.) Kuntze **(79)** BA, LA, MO, OT; 3200–5700′; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Thelesperma subnudum A. Gray **(9)** OT; 4390–5160′; rup, sgp
Thymophylla aurea (A. Gray) Greene ex Britton var. *aurea* **(5)** OT; 4300–4620′; rd, rup, sgp
Townsendia exscapa (Richardson) Porter **(4)** LA, OT; 4640–6050′; pjw, rup
■ *Tragopogon dubius* Scop. **(78)** BA, LA, MO, OT; 3380–6030′; cgf, mgp, pjw, rd, rup, sgp, ssp, stp
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray **(11)** BA, LA, OT; 4410–5860′; pjw, rd, rup, sgp
● *Vernonia marginata* (Torr.) Raf. **(1)** MO; 3290–3290′; ssp
Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartm. var. *glaberrimum* (Rydb.) D.R. Morgan & R.L. Hartm. **(18)** BA, LA, MO, OT; 3310–6060′; cgf, jw, mgp, pjw, rup, sgp, ssp
Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartm. var. *paradoxum* (B.L. Turner & R.L. Hartm.) D.R. Morgan & R.L. Hartm. **(13)** BA, LA, MO, OT; 3370–4940′; jw, rup, sgp, ssp
Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartm. var. *spinulosum* **(131)** BA, LA, MO, OT; 3200–5940′; jw, mgp, pjw, rd, rup, sgp, ssp, stp
■ *Xanthium spinosum* L. **(1)** LA; 5960–5960′; sgp, stp
Xanthium strumarium L. **(14)** BA, LA, OT; 4300–6210′; rd, stp
Zinnia grandiflora Nutt. **(75)** BA, LA, MO, OT; 3410–6130′; mgp, pjw, rup, sgp, ssp, stp

Boraginaceae
Cryptantha cinerea (Greene) Cronquist var. *cinerea* **(3)** BA, OT; 4250–4800′; mgp, sgp
Cryptantha cinerea (Greene) Cronquist var. *jamesii* Cronquist **(31)** BA, LA, MO, OT; 3450–5560′; jw, mgp, pjw, rup, sgp, ssp
Cryptantha crassisepala (Torr. & A. Gray) Greene **(1)** MO; 3380–3380′; ssp
Cryptantha minima Rydb. **(40)** BA, LA, MO, OT; 3370–5720′; cgf, jw, mgp, pjw, rup, sgp, ssp
Cryptantha thyrsiflora (Greene) Payson **(27)** BA, LA, OT; 4370–5370′; jw, mgp, pjw, rup, sgp
Cynoglossum officinale L. **(2)** LA; 5960–6090′; pjw, rd
Heliotropium convolvulaceum (Nutt.) A. Gray var. *convolvulaceum* **(4)** BA, MO; 3370–4460′; cgf, sgp, ssp
Lappula occidentalis (S. Watson) Greene var. *cupulata* (A. Gray) L.C. Higgins **(10)** BA, LA, MO, OT; 3420–5980′; rd, rup, sgp, stp
Lappula occidentalis (S. Watson) Greene var. *occidentalis* **(23)** BA, LA, MO, OT; 3390–5980′; cgf, mgp, pjw, rd, rup, sgp
Lithospermum incisum Lehm. **(63)** BA, LA, MO, OT; 3290–6050′; cgf, mgp, pjw, rup, sgp, ssp
Mertensia brevistyla S. Watson **(1)** LA; 5990–6050′; pjw
Mertensia lanceolata (Pursh) A. DC. **(1)** LA; 6060–6440′; pjw
Onosmodium molle Michx. var. *occidentale* (Mack.) I.M. Johnst. **(5)** BA, LA, OT; 4300–5360′; mgp, sgp

Brassicaceae [including Capparaceae]
Alyssum simplex Rudolphi **(1)** OT; 4570–4570′; sgp
Boechera fendleri (S. Watson) W.A. Weber **(1)** LA; 5140–5140′; pjw
■ *Camelina microcarpa* Andrz. ex DC. **(17)** BA, LA, OT; 4290–5740′; mgp, pjw, rd, rup, sgp, stp
■ *Capsella bursa-pastoris* (L.) Medik. **(1)** LA; 5110–5110′; rip, rd, stp
■ *Chorispora tenella* (Pall.) DC. **(14)** LA, MO, OT; 3420–5740′; jw, rd, rup, sgp, ssp, stp
Cleome serrulata Pursh **(4)** LA, OT; 4350–5370′; jw
■ *Conringia orientalis* (L.) Dumort. **(1)** OT; 4800–4800′; sgp
Descurainia pinnata (Walter) Britton var. *osmiarum* (Cockerell) Shinners **(15)** BA, LA, MO, OT; 3380–6050′; mgp, pjw, rd, sgp, ssp, stp
■ *Descurainia sophia* (L.) Webb ex Prantl **(42)** BA, LA, MO, OT; 3370–6030′; cgf, mgp, pjw, rd, rup, sgp, ssp, stp
Draba reptans (Lam.) Fernald **(3)** LA, OT; 4290–5560′; jw, pjw, sgp
Erysimum asperum (Nutt.) DC. **(55)** BA, LA, MO, OT; 3200–6030′; jw, mgp, rd, rup, sgp, ssp
■ *Erysimum repandum* L. **(1)** OT; 4500–4500′; rd
Lepidium densiflorum Schrad. var. *densiflorum* **(35)** BA, LA, MO, OT; 3380–6050′; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Lepidium densiflorum Schrad. var. *macrocarpum* G. A. Mulligan **(3)** BA, MO; 3430–4780′; rup, ssp

Physaria fendleri (A. Gray) O'Kane & Al-Shehbaz **(33)** LA, OT; 4240–4990'; mgp, pjw, rup, sgp
Physaria montana (A. Gray) Greene **(1)** LA; 5990–6050'; pjw
Physaria ovalifolia (Rydb. ex Britton) O'Kane & Al-Shehbaz ssp. *ovalifolia* **(6)** BA, MO; 3480–4800'; mgp, rup, sgp, ssp
Polanisia dodecandra (L.) DC. var. *trachysperma* (Torr. & A. Gray) H. H. Iltis **(27)** BA, LA, MO, OT; 3290–5430'; jw, mgp, rd, rup, sgp, ssp
Rorippa sinuata (Nutt.) Hitchc. **(5)** BA, LA, OT; 4500–6130'; rd, sgp, stp
■ *Sisymbrium altissimum* L. **(10)** BA, LA, MO; 3370–4880'; cgf, rip, rd, rup, sgp, ssp, stp
Stanleya pinnata (Pursh) Britton var. *pinnata* **(12)** LA, OT; 4300–5370'; rup, sgp
Thelypodium wrightii A. Gray ssp. *oklahomensis* Al-Shehbaz **(2)** BA, LA; 4260–4510'; jw, mgp

Cactaceae
Coryphantha vivipara (Nutt.) Britton & Rose **(8)** BA, LA, MO, OT; 3660–5100'; jw, pjw, rd, rup, sgp
Cylindropuntia imbricata (Haw.) F.M. Knuth var. *imbricata* **(40)** BA, LA, OT; 4230–5980'; jw, mgp, rup, sgp
Echinocereus reichenbachii (Walp.) Haage ex Britton & Rose **(17)** BA, LA, OT; 4350–4950'; jw, mgp, rup, sgp
Echinocereus viridiflorus Engelm. **(18)** BA, LA, OT; 4290–6050'; jw, pjw, sgp, ssp
Opuntia fragilis (Nutt.) Haw. **(6)** LA, MO, OT; 3490–6080'; pjw, rd, sbs, sgp
Opuntia phaeacantha Engelm. **(25)** BA, LA, MO, OT; 3360–4980'; cgf, jw, rup, sgp, ssp
Opuntia polyacantha Haw. var. *polyacantha* **(39)** BA, LA, MO, OT; 3350–6030'; jw, mgp, pjw, rd, rup, sgp
Opuntia tortispina Engelm. & J.M. Bigelow **(11)** BA, LA, MO, OT; 3410–5360'; cgf, jw, mgp, sgp, ssp

Campanulaceae
○ *Lobelia cardinalis* L. **(1)** BA; 4300–4300'; rip
Triodanis perfoliata (L.) Nieuwl. **(4)** BA, MO; 3360–4440'; cgf, rip

Cannabaceae
Celtis occidentalis L. **(8)** BA, LA, MO, OT; 3360–5450'; cgf, mgp, pjw, rup, sgp
Celtis reticulata Torr. **(16)** BA, LA, MO, OT; 3310–5140'; cgf, jw, mgp, pjw, rup, sgp

Caprifoliaceae
■ *Kolkwitzia amabilis* Graebn. **(1)** BA; 4620–4620'; sgp
Lonicera tatartica L. **(1)** BA; 4350'; rd
Symphoricarpos occidentalis Hook. **(2)** LA; 4440–5900'; rip
Symphoricarpos oreophilus A. Gray var. *oreophilus* **(1)** LA; 6060–6440', pjw

Caryophyllaceae
Eremogone hookeri (Nutt.) W.A. Weber var. *hookeri* **(15)** LA, OT; 4350–5150'; mgp, pjw, rup, sgp
Eremogone hookeri (Nutt.) W.A. Weber var. *pinetorum* (A. Nelson) Dorn **(3)** OT; 4290–4760'; pjw, rup
Paronychia jamesii Torr. & A. Gray **(18)** BA, LA, MO, OT; 3410–5560'; jw, mgp, pjw, rup, sgp, ssp
Paronychia sessiliflora Nutt. **(17)** LA, OT; 4240–6210'; jw, rup, sgp
Silene antirrhina L. **(4)** BA, LA, OT; 4250–4610'; jw, pjw, rip

Celastraceae
■ *Euonymus bungeanus* Maxim. **(1)** BA; 4620–4620'; sgp

Commelinaceae
Commelina erecta L. **(5)** BA, LA, MO; 3330–5120'; mgp, pjw, rip, ssp
Tradescantia occidentalis (Britton) Smyth var. *occidentalis* **(27)** BA, LA, MO, OT; 3310–5560'; cgf, jw, mgp, rip, sgp, ssp

Convolvulaceae
■ *Convolvulus arvensis* L. **(81)** BA, LA, MO, OT; 3360–6030'; jw, mgp, rip, rd, rup, sgp, ssp, stp
Convolvulus equitans Benth. **(23)** BA, LA, MO, OT; 3490–5940'; jw, mgp, rd, rup, sgp
■ *Cuscuta approximata* Bab. **(1)** OT; 4480–4480'; sgp
Cuscuta cuspidata Engelm. **(1)** BA; 4910–4910'; mgp
Cuscuta pentagona Engelm. **(1)** BA; 4140–4140'; rup
● *Cuscuta umbellata* Kunth **(5)** LA; 3250–4570'; jw, rip, rd
Evolvulus nuttallianus Schult. **(71)** BA, LA, MO, OT; 3310–5980'; cgf, jw, mgp, pjw, rup, sgp, ssp
Ipomoea leptophylla Torr. **(45)** BA, LA, MO, OT; 3270–6060'; cgf, mgp, pjw, rd, rup, sgp, ssp

Cucurbitaceae
Cucurbita foetidissima Kunth **(110)** BA, LA, MO, OT; 3270–5960'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Cyclanthera dissecta (Torr. & A. Gray) Arn. **(1)** LA; 4870–4870'; rip

Cyperaceae
Bolboschoenus maritimus (L.) Palla ssp. *paludosus* (A. Nelson) T. Koyama **(6)** BA, LA, MO, OT; 3420–5040'; rip, stp
Carex aquatilis Wahlenb. var. *aquatilis* **(1)** LA; 5030–5030'; rip
Carex brevior (Dewey) Mack. ex Lunell **(7)** BA, LA; 4250–6090'; pjw, rip
Carex gravida L. H. Bailey **(16)** BA, LA; 4250–5530'; jw, mgp, pjw, rip, rup, sgp, stp
Carex hystericina Muhl. ex Willd. **(5)** BA, LA, OT; 4340–5530'; rip
Carex inops L. H. Bailey ssp. *heliophila* **(1)** LA; 5990–6050'; pjw
Carex lanuginosa Michx. **(1)** BA; 4250–4250'; rip
Carex praegracilis W. Boott **(2)** LA, OT; 4570–5030'; rip
Carex vulpinoidea Michx. **(1)** BA; 4250–4250'; rip
Cyperus bipartitus Torr. **(2)** BA; 4300–4760'; mgp, pjw
Cyperus lupulinus (Spreng) Marcks var. *lupulinus* **(1)** BA; 4255'; rip
! *Cyperus retroflexus* Buckley **(1)** MO; 3380–3380'; cgf
Cyperus schweinitzii Torr. **(10)** BA, MO; 3370–4820'; cgf, mgp, rip, rup, sgp, ssp, stp
Cyperus squarrosus L. **(1)** BA; 4300–4300'; mgp
Eleocharis macrostachya Britton **(14)** BA, LA, MO, OT; 3490–5470'; rip, stp
Eleocharis palustris (L.) Roem. & Schult. **(11)** BA, LA, MO, OT; 3370–5740'; rip, stp
● *Eleocharis rostellata* (Torr.) Torr. **(2)** MO; 3410–3420'; cgf, rip
Schoenoplectus pungens (Vahl) Palla var. *pungens* **(26)** BA, LA, MO, OT; 3310–5110'; cgf, rip, stp
Schoenoplectus tabernaemontani (C. C. Gmel.) Palla **(15)** BA, LA, MO, OT; 3340–6090'; rip, stp
Scirpus pallidus (Britton) Fernald **(6)** BA, LA, OT; 4250–5530'; rip, stp

Dipsacaceae
■ *Dipsacus fullonum* L. **(1)** OT; 4160–4160'; rip

Elaeagnaceae
■ *Elaeagnus angustifolia* L. **(7)** BA, LA, MO, OT; 3550–5470'; rip, rd, rup, sgp

Elatinaceae
Bergia texana (Hook.) Seub. ex Walp. **(1)** OT; 6130–6130'; stp

Euphorbiaceae
○ *Argythamnia humilis* (Engelm. & A. Gray) Müll. Arg. var. *humilis* **(2)** OT; 4570–4650'; rd, sgp
Argythamnia mercurialina (Nutt.) Müll. Arg. **(3)** BA, MO; 3430–4300'; mgp, rip, rup
Chamaesyce fendleri (Torr. & A. Gray) Small **(69)** BA, LA, MO, OT; 3410–6130'; mgp, pjw, rd, rup, sgp, ssp
Chamaesyce glyptosperma (Engelm.) Small **(31)** BA, LA, MO, OT; 3290–5940'; cgf, jw, rd, rup, sgp, ssp

Chamaesyce lata (Engelm.) Small **(33)** BA, LA, MO, OT; 3410–4990′; jw, mgp, pjw, rd, rup, sgp, ssp
Chamaesyce missurica (Raf.) Shinners **(15)** BA, LA, MO; 3370–5170′; cgf, jw, mgp, sgp, ssp
Chamaesyce revoluta (Engelm.) Small **(5)** OT; 4300–5040′; jw
■ *Chamaesyce serpyllifolia* (Pers.) Small **(10)** LA, OT; 4440–5770′; rd, rup, sgp
Chamaesyce stictospora (Engelm.) Small **(14)** BA, LA, OT; 3200–5860′; jw, rd, rup, sgp
Croton texensis (Klotzsch) Müll. Arg. **(98)** BA, LA, MO, OT; 3290–5450′; cgf, mgp, pjw, rd, rup, sgp, ssp, stp
Euphorbia dentata Michx. **(26)** BA, LA, MO, OT; 3360–5860′; cgf, jw, mgp, rd, rup, sgp, ssp
Euphorbia marginata Pursh **(36)** BA, LA, MO, OT; 3490–6130′; pjw, rd, rup, sgp, ssp, stp
Euphorbia spathulata Lam. **(5)** LA, OT; 4350–4980′; pjw, rup, sgp
Stillingia sylvatica Garden ex L. **(1)** MO; 3370–3370′; ssp
Tragia ramosa Torr. **(31)** BA, LA, OT; 4140–5770′; jw, mgp, pjw, rup, sgp, ssp

Fabaceae

Amorpha canescens Pursh **(4)** BA, LA; 4300–5150′; jw, mgp, rip
Amorpha fruticosa L. **(5)** LA, OT; 4160–4610′; pjw, rip
Astragalus bisulcatus (Hook.) A. Gray var. *bisulcatus* **(5)** LA, OT; 4390–6090′; pjw, rd, rup, sgp
Astragalus ceramicus E. Sheld. var. *filifolius* (A. Gray) F.J. Herm. **(1)** BA; 4250–4260′; cgf
Astragalus crassicarpus Nutt. var. *crassicarpus* **(1)** LA; 5600–5600′; sgp
Astragalus crassicarpus Nutt. var. *paysonii* (E. H. Kelso) Barneby **(5)** BA; 4080–4880′; mgp, sgp
Astragalus drummondii Douglas ex Hook. **(1)** LA; 6440–6440′; sgp
Astragalus gracilis Nutt. **(23)** BA, LA, OT; 4080–6050′; mgp, pjw, rup, sgp
Astragalus lentiginosus Douglas ex Hook. var. *diphysus* (A. Gray) M.E. Jones **(3)** LA; 4350–4610′; jw, pjw
Astragalus lotiflorus Hook. **(13)** BA, MO, OT; 3420–4800′; mgp, sgp, ssp
Astragalus missouriensis Nutt. var. *amphibolus* Barneby **(8)** BA, LA, OT; 4370–5560′; mgp, rup, sgp
Astragalus missouriensis Nutt. var. *missouriensis* **(35)** BA, LA, MO, OT; 3480–5980′; jw, mgp, pjw, rup, sgp, ssp
Astragalus mollissimus Torr. var. *mollissimus* **(13)** BA, LA; 4050–5360′; jw, mgp, pjw, rup, sgp
Astragalus nuttallianus DC. var. *austrinus* (Small) Barneby **(2)** LA, OT; 4290–4610′; pjw
Astragalus pectinatus (Hook.) Douglas ex G. Don **(1)** OT; 4310–4310′; ssp
Astragalus racemosus Pursh var. *longisetus* M.E. Jones **(4)** LA, OT; 4550–5740′; rup, sgp
Astragalus racemosus Pursh var. *racemosus* **(3)** LA, OT; 4860–5370′; mgp, rup
Astragalus shortianus Nutt. **(1)** OT; 4520–4520′; rup
■ *Caragana arborescens* Lam. **(1)** BA; 4620–4620′; sgp
Dalea aurea Nutt. ex Pursh **(12)** BA, LA, MO; 3350–6060′; jw, mgp, pjw, rup, sgp, ssp
Dalea candida Michx. var. *oligophylla* (Torr.) Shinners **(36)** BA, LA, MO, OT; 3430–6060′; mgp, pjw, rup, sgp, ssp
● *Dalea cylindriceps* Barneby **(4)** BA, MO; 3370–4390′; cgf, ssp
Dalea enneandra Nutt. **(15)** BA, LA, MO; 3290–4770′; jw, mgp, pjw, rup, sgp, ssp
Dalea formosa Torr. **(1)** BA; 4250–4440′; jw
● *Dalea jamesii* (Torr.) Torr. & A. Gray **(26)** BA, LA, MO, OT; 3370–5560′; jw, mgp, pjw, rup, sgp, ssp
Dalea lanata Spreng. var. *lanata* **(1)** MO; 3370–3370′; ssp
Dalea nana Torr. ex A. Gray var. *nana* **(2)** BA, MO; 3310–4240′; cgf, sgp
Dalea purpurea Vent. var. *arenicola* (Wemple) Barneby **(36)** BA, LA, OT; 4150–4950′; jw, mgp, pjw, rup, sgp, ssp
Dalea purpurea Vent. var. *purpurea* **(4)** OT; 4290–4980′; pjw, rup
Dalea tenuifolia (A. Gray) Shinners **(7)** BA, MO; 3430–4980′; pjw, rup, sgp
Desmanthus cooleyi (Eaton) Trel. **(5)** BA; 3870–4590′; sgp, ssp
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald **(4)** MO, OT; 3350–4210′; rip, sgp, ssp
Gleditsia triacanthos L. **(9)** BA, LA, MO, OT; 3410–5470′; cgf, jw, rip, rd, sgp
Glycyrrhiza lepidota Pursh **(18)** BA, LA, MO, OT; 3350–6090′; cgf, rip, ssp
Hedysarum boreale Nutt. var. *boreale* **(6)** LA, OT; 4380–4510′; jw, rup, sgp
Hoffmannseggia drepanocarpa A. Gray **(13)** BA, OT; 4280–4940′; mgp, pjw, rup, sgp
Hoffmannseggia glauca (Ortega) Eifert **(5)** MO, OT; 3420–4780′; jw
Lathyrus eucosmus Butters & H. St. John **(3)** OT; 4500–4930′; rup
Lathyrus polymorphus Nutt. var. *incanus* (J. G. Sm. & Rydb. ex Rydb.) Dorn **(2)** BA, OT; 4780–4800′; mgp, ssp
Lupinus plattensis S. Watson **(2)** BA; 4240–4800′; mgp, ssp
Lupinus pusillus Pursh var. *pusillus* **(5)** BA, OT; 4230–4400′; mgp, pjw, rup
■ *Medicago lupulina* L. **(2)** BA; 4760–4800′; pjw, rup
■ *Medicago sativa* L. **(7)** BA, OT; 4210–4930′; rip, rd, rup, sgp
■ *Melilotus albus* Medik. **(40)** BA, LA, MO, OT; 3370–5860′; cgf, pjw, rip, rd, sgp, ssp
■ *Melilotus officinalis* (L.) Pall. **(61)** BA, LA, MO, OT; 3360–6090′; cgf, mgp, pjw, rd, rup, sgp, ssp
Mimosa borealis A. Gray **(5)** BA, LA; 4300–5150′; mgp, pjw
Mimosa quadrivalvis L. var. *angustata* (Torr. & A. Gray) Barneby **(3)** MO; 3310–3410′; cgf, ssp
Oxytropis lambertii Pursh var. *bigelovii* A. Gray **(1)** MO; 3480–3480′; ssp
Pediomelum cuspidatum (Pursh) Rydb. **(1)** MO; 3430–3540′; rup
Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *hypogaeum* **(2)** BA, OT; 4310–4860′; jw, sgp
Pomaria jamesii (Torr. & A. Gray) Walp. **(29)** BA, LA, MO, OT; 3410–4990′; jw, mgp, pjw, rup, sgp, ssp
Psoralidium lanceolatum (Pursh) Rydb. **(8)** BA, MO; 3370–4910′; cgf, mgp, rup, sgp
Psoralidium tenuiflorum (Pursh) Rydb. **(123)** BA, LA, MO, OT; 3200–6210′; jw, mgp, pjw, rd, rup, sgp, ssp
Robinia pseudoacacia L. **(1)** BA; 4270–4270′; rd
Sophora nuttalliana B.L. Turner **(39)** BA, LA, MO, OT; 3430–6080′; jw, mgp, pjw, rd, rup, sgp
Strophostyles leiosperma (Torr. & A. Gray) Piper **(1)** MO; 3370–3370′; rip
Vicia americana Muhl. ex Willd. var. *minor* Hook. **(12)** LA, OT 4310–6440′; jw, mgp, rd, rup, sgp, ssp
Vicia ludoviciana Nutt. var. *ludoviciana* **(5)** LA, OT; 4350–5360′; mgp, rup, sgp

Fagaceae

× *Quercus* ×*undulata* Torr. **(9)** BA, LA; 4730–6090′; jw, pjw
Quercus gambelii Nutt. **(3)** BA, LA; 4860–6080′; pjw

Frankeniaceae

Frankenia jamesii Torr ex A. Gray **(4)** OT; 4390–4990′; rup, sgp

Gentianaceae

Eustoma grandiflorum (Raf.) Shinners **(1)** MO; 3370–3370′; rip
○ *Frasera coloradensis* (C.M. Rogers) D.M. Post **(1)** BA; 4980–4980′; jw

Geraniaceae

■ *Erodium cicutarium* (L.) L'Hér. ex Aiton **(9)** LA, MO, OT; 3470–5740′; cgf, rd, rup, sgp, stp

Grossulariaceae

Ribes aureum Pursh var. *aureum* **(13)** BA, LA, OT; 41500–6090′; jw, mgp, pjw, rup

Ribes cereum Douglas **(12)** BA, LA, OT; 4320–6080′; mgp, pjw, rup, sgp

Ribes leptanthum A. Gray **(7)** BA, LA; 4230–6440′; jw, mgp, pjw

Haloragaceae

Myriophyllum sibiricum Kom. **(1)** LA; 4870–4870′; rip

Hydrangeaceae

Philadelphus microphyllus A. Gray **(1)** OT; 4930–4930′; rip

Hydrophyllaceae

Ellisia nyctelea (L.) L. **(1)** LA; 5740–5740′; sgp

Juglandaceae

Juglans nigra L. **(2)** BA; 4340–4620′; mgp, sgp

Juncaceae

Juncus arcticus Willd. var. *balticus* (Willd.) Trautv. **(2)** MO, OT; 3550–4300′; rip

Juncus dudleyi Wiegand **(9)** BA, LA, OT; 4230–6090′; rip, stp

Juncus interior Wiegand **(3)** BA, OT; 4340–4930′; rip

Juncus longistylis Torr. **(1)** LA; 6080–6080′; rip

Juncus nodosus L. **(1)** BA; 4250–4250′; rip

Juncus torreyi Coville **(10)** BA, LA, MO, OT; 3380–5370′; rip

Lamiaceae

Hedeoma drummondii Benth. **(3)** BA, OT; 4820–5100′; jw, rup, sgp

Lycopus americanus Muhl. ex W. P. C. Barton **(2)** BA; 4300–4760′; mgp, pjw

■ *Marrubium vulgare* L. **(19)** BA, LA, OT; 4290–6130′; mgp, pjw, rip, rd, rup, sgp

Mentha arvensis L. **(2)** LA; 5530–5530′; rip

Monarda pectinata Nutt. **(11)** BA, LA, MO, OT; 3410–4860′; mgp, pjw, rip, rup, sgp, ssp

Salvia reflexa Hornem. **(8)** BA, LA, MO, OT; 3480–5320′; pjw, rup, sgp

Teucrium canadense L. var. *occidentale* (A. Gray) E. M. McClint. & Epling **(2)** OT; 4210–4240′; rup

Teucrium laciniatum Torr. **(36)** BA, LA, MO, OT; 3380–6090′; cgf, jw, pjw, rd, rup, sgp, ssp

Liliaceae

Leucocrinum montanum Nutt. ex A. Gray **(3)** BA, OT; 4560–4900′; jw, mgp

Linaceae

Linum lewisii Pursh var. *lewisii* **(18)** LA, OT; 4360–6080′; jw, mgp, pjw, rd, rup, sgp

Linum pratense (Norton) Small **(19)** BA, LA, MO, OT; 3350–5740′; mgp, pjw, rup, sgp, ssp

Linum puberulum (Engelm.) A. Heller **(4)** LA, OT; 4290–5740′; pjw, sgp

Linum rigidum Pursh **(24)** BA, MO, OT; 3420–4880′; mgp, pjw, rd, rup, sgp, ssp

Loasaceae

Mentzelia albicaulis (Douglas ex Hook.) Douglas ex Torr. & A. Gray **(3)** OT; 4290–4800′; mgp, pjw, rup

Mentzelia decapetala (Pursh ex Sims) Urb. & Gilg ex Gilg **(8)** BA, LA, OT; 4300–6130′; jw, mgp, rd, rup, sgp

Mentzelia multiflora (Nutt.) A. Gray **(34)** BA, LA, OT; 4220–4950′; pjw, rup, sgp

Mentzelia nuda (Pursh) Torr. & A. Gray **(29)** BA, LA, MO, OT; 3270–5600′; jw, mgp, pjw, rup, sgp, ssp

Mentzelia oligosperma Nutt. ex Sims **(3)** BA, LA; 4250–4440′; jw, mgp

Mentzelia rusbyi Wooton **(17)** BA, LA, OT; 4050–5370′; jw, pjw, rup, sgp

Mentzelia reverchonii (Urb. & Gilg) H.J. Thomp. & Zavort. **(7)** LA, OT; 4330–5360′; mgp, sgp

Malvaceae

Callirhoë involucrata (Torr. & A. Gray) A. Gray var. *lineariloba* (Torr. & A. Gray) A. Gray **(7)** MO; 3310–3540′; cgf, rup, sgp, ssp

■ *Hibiscus trionum* L. **(1)** OT; 4650–4650′; rd

■ *Malva neglecta* Wallr. **(4)** BA, LA; 4920–6030′; rip, rd, sgp

● *Sphaeralcea angustifolia* (Cav.) G. Don **(31)** BA, LA, MO, OT; 3420–6210′; jw, mgp, pjw, rd, rup, sgp, ssp

Sphaeralcea coccinea (Nutt.) Rydb. **(111)** BA, LA, MO, OT; 3310–6030′; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

Martyniaceae

Proboscidea louisianica (Mill.) Thell. ssp. *louisianica* **(9)** BA, LA, OT; 4340–6130′; jw, mgp, rd, sgp, ssp

Molluginaceae

Mollugo verticillata L. **(3)** BA, MO; 3440–4300′; sgp, ssp

Moraceae

Maclura pomifera (Raf.) C.K. Schneid. **(1)** BA; 4300–4300′; sgp

■ *Morus alba* L. **(6)** BA, LA, MO, OT; 3530–5470′; jw, rd, rup, sgp, ssp

Nyctaginaceae

Abronia fragrans Nutt. ex Hook. **(11)** BA, LA, MO; 3370–5560′; jw, mgp, rup, sgp, ssp

Mirabilis albida (Walter) Heimerl **(6)** BA, LA; 4140–4970′; pjw, rup, ssp

Mirabilis glabra (S. Watson) Standl. **(4)** MO; 3370–3470′; cgf, rup

Mirabilis linearis (Pursh) Heimerl var. *linearis* **(52)** BA, LA, MO, OT; 3290–5370′; cgf, mgp, pjw, rd, rup, sgp, ssp

Mirabilis multiflora (Torr.) A. Gray var. *multiflora* **(8)** BA, LA, OT; 4350–5240′; jw, pjw, rup, sgp, ssp

Mirabilis nyctaginea (Michx.) MacMill. **(8)** LA, MO, OT; 3360–4870′; cgf

Tripterocalyx micranthus (Torr.) Hook. **(1)** OT; 4480–4480′; sgp

Oleaceae

■ *Fontanesia phillyreoides* Labill. ssp. *fortunei* (Carrière) Yaltirik **(1)** BA; 4630–4630′; sgp

Fraxinus pennsylvanica Marshall **(3)** BA, MO, OT; 3550–4330′; rip, sgp

■ *Syringa vulgaris* L. **(1)** BA; 4350–4350′; sgp

Onagraceae

Oenothera albicaulis Pursh **(8)** BA, LA, OT; 4040–5740′; mgp, sgp, ssp

Oenothera cespitosa Nutt. var. *cespitosa* **(2)** OT; 4640–4800′; jw, sgp

Oenothera cinerea (Wooton & Standl.) W.L. Wagner & Hoch ssp. *cinerea* **(6)** BA, MO; 3360–4460′; cgf, rup, ssp

Oenothera coronopifolia Torr. & A. Gray **(2)** LA, OT; 4320–5230′; jw, sgp

Oenothera curtiflora W.L. Wagner & Hoch **(25)** BA, LA, MO, OT; 3370–5420′; cgf, mgp, pjw, rup, sgp, ssp

● *Oenothera engelmannii* (Small) Munz **(3)** MO; 3310–3410′; cgf, ssp

○ *Oenothera harringtonii* W.L. Wagner **(6)** OT; 4440–4950′; rup

Oenothera hartwegii Benth. ssp. *pubescens* (A. Gray) W.L. Wagner & Hoch **(5)** BA, LA; 4730–5150′; jw, pjw, rup, ssp

Oenothera howardii (A. Nelson) W.L. Wagner **(1)** OT; 4390–4390′; rup

Oenothera latifolia (Rydb.) Munz **(8)** BA, LA, MO; 3350–5170′; cgf, mgp, sgp, ssp

Oenothera lavandulifolia Torr. & A. Gray **(27)** BA, LA, MO, OT; 3480–5980′; jw, mgp, rup, sgp, ssp

Oenothera serrulata Nutt. **(20)** BA, LA, MO; 3310–5170′; cgf, mgp, rup, sgp, ssp

Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch **(98)** BA, LA, MO, OT; 3290–5980′; jw, mgp, pjw, rd, rup, sgp, ssp

Oenothera villosa Thunb. var. *villosa* **(1)** BA; 4760–4760′; sgp

Orobanchaceae

Castilleja integra A. Gray **(5)** LA, OT; 5100–6080′; pjw, sgp

Castilleja sessiliflora Pursh **(14)** LA, OT; 4300–5740′; jw, mgp, rup, sgp

Orobanche fasciculata Nutt. **(1)** LA; 6060–6440′; pjw

Orobanche ludoviciana Nutt. var. *multiflora* (Nutt.) G. Beck **(5)** BA, LA, OT; 4310–5600'; mgp, pjw, sgp, ssp

Oxalidaceae

Oxalis dillenii Jacq. **(2)** BA; 4230–4440'; jw, mgp

Papaveraceae

Argemone hispida A. Gray **(3)** MO, OT; 3330–4930'; rup, ssp

Argemone polyanthemos (Fedde) G.B. Ownbey **(6)** BA, LA, OT; 4250–4940'; jw, rd, sgp, ssp

Argemone squarrosa Greene var. *squarrosa* **(6)** BA, MO; 3350–4050'; rup, sgp, ssp

Corydalis aurea Willd. var. *aurea* **(5)** MO; 3380–3490'; cgf, rip, ssp

Corydalis aurea Willd. var. *occidentalis* Engelm. ex A. Gray **(4)** BA, MO, OT; 3450–4800'; mgp, pjw, sgp, ssp

Phrymaceae

Mimulus glabratus Kunth var. *jamesii* (Torr. & A. Gray ex Benth.) A. Gray **(1)** LA; 5120–5120'; rip

Plantaginaceae [including Scrophulariaceae in part]

■ *Linaria dalmatica* (L.) Mill. var. *dalmatica* **(3)** LA; 5260–5680'; rd, sgp

Penstemon albidus Nutt. **(16)** BA, LA, MO, OT; 3480–5560'; rup, sgp, ssp

Penstemon ambiguus Torr. **(7)** BA, MO; 3370–4490'; sgp, ssp

Penstemon angustifolius Nutt. ex Pursh var. *caudatus* (A. Heller) Rydb. **(20)** BA, LA, OT; 4310–5980'; jw, mgp, pjw, rup, sgp

Penstemon auriberbis Pennell **(3)** OT; 4500–4800'; mgp

Penstemon buckleyi Pennell **(1)** BA; 4280–4280'; mgp

○ *Penstemon jamesii* Benth. **(3)** BA, LA; 4610–5980'; sgp

Penstemon virgatus A. Gray var. *asa-grayi* (Crosswh.) Dorn **(1)** OT; 4480–4480'; sgp

■ *Plantago major* L. **(2)** LA; 5100–5120'; rip

Plantago patagonica Jacq. **(52)** BA, LA, MO, OT; 3310–6050'; cgf, pjw, rup, sbs, sgp, ssp

Veronica anagallis-aquatica L. **(9)** BA, LA; 4250–5130'; rip

Veronica catenata Pennell **(1)** BA; 4760–4760'; rip

Veronica peregrina L. var. *xalapensis* (Kunth) H. St. John & F.W. Warren **(4)** LA; 5110–5740'; rip

Poaceae

● *Achnatherum hymenoides* (Roem. & Schult.) Barkworth **(40)** BA, LA, MO, OT; 3350–6050'; cgf, mgp, pjw, rd, rup, sgp, ssp

Achnatherum robustum (Vasey) Barkworth **(3)** LA; 5860–5960'; sgp

■ *Aegilops cylindrica* Host **(8)** BA, LA, OT; 4300–5190'; jw, rup, sgp

■ *Agropyron cristatum* (L.) Gaertn. var. *cristatum* **(5)** LA, OT; 4390–5260'; rd, rup, sgp

■ *Agropyron cristatum* (L.) Gaertn. var. *desertorum* (Fisch. ex Link) Dorn **(3)** BA; 4220–4940'; sgp, ssp

■ *Agrostis gigantea* Roth **(2)** LA, OT; 4690–4930'; rip

■ *Agrostis stolonifera* L. **(3)** LA; 5100–5900'; rip

Andropogon gerardii Vitman **(2)** BA; 4300–4820'; mgp

Andropogon hallii Hack. **(3)** BA, LA; 4760–6060'; pjw, rup, ssp

Aristida adscensionis L. **(6)** BA, LA, MO, OT; 3380–5030'; cgf, jw, mgp

Aristida divaricata Humb. & Bonpl. ex Willd. **(5)** BA; 4760–4970'; mgp, pjw, ssp

Aristida purpurea Nutt. var. *fendleriana* (Steud.) Vasey **(6)** LA, MO, OT; 3410–4580'; jw, rup, sgp, ssp

Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey **(193)** BA, LA, MO, OT; 3290–6440'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred **(4)** LA, OT; 4560–5120'; pjw, rup, sgp

Aristida purpurea Nutt. var. *purpurea* **(39)** BA, LA, MO, OT; 3330–5860'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

Aristida purpurea Nutt. var. *wrightii* (Nash) Allred **(2)** BA, LA; 4320–4410'; jw, mgp

■ *Bothriochloa ischaemum* (L.) Keng **(7)** BA, MO; 3360–4300'; cgf, rd, rup, sgp, ssp

Bothriochloa laguroides (DC.) Herter **(81)** BA, LA, MO, OT; 3220–5860'; cgf, jw, mgp, rd, rup, sgp, ssp

● *Bothriochloa springfieldii* (Gould) Parodi **(4)** BA, LA, OT; 4220–4930'; jw, mgp, sgp

Bouteloua curtipendula (Michx.) Torr. var. *curtipendula* **(84)** BA, LA, MO, OT; 3200–6210'; cgf, mgp, pjw, rd, rup, sgp, ssp

Bouteloua eriopoda (Torr.) Torr. **(9)** BA, LA, OT; 4220–4580'; jw, mgp, ssp

Bouteloua gracilis (Kunth) Lag. ex Griffiths **(53)** BA, LA, MO, OT; 3200–5770'; jw, mgp, rd, rup, sgp, ssp

Bouteloua hirsuta Lag. var. *hirsuta* **(26)** BA, LA, OT; 3970–6060'; jw, mgp, pjw, rup, sgp, ssp

Bromus carinatus Hook. & Arn. **(3)** LA, MO; 3410–5960'; jw, sgp, ssp

■ *Bromus commutatus* Schrad. **(2)** BA, MO; 3550–4170'; rd, sgp

■ *Bromus inermis* Leyss. **(10)** LA, MO, OT; 3420–5800'; mgp, rd, rup, sgp, ssp

■ *Bromus japonicus* Thunb. ex Murray **(57)** BA, LA, MO, OT; 3360–5810'; cgf, jw, mgp, rd, rup, sgp, ssp

■ *Bromus tectorum* L. **(38)** BA, LA, MO, OT; 3380–5740'; cgf, mgp, pjw, rd, rup, sgp, ssp

Buchloë dactyloides (Nutt.) Engelm. **(57)** BA, LA, MO, OT; 3200–6030'; cgf, mgp, pjw, rd, rup, sgp, ssp

Calamovilfa gigantea (Nutt.) Scribn. & Merr. **(2)** BA, MO; 3470–4910'; mgp, rip

Cenchrus longispinus (Hack.) Fernald **(27)** BA, LA, MO, OT; 3300–5680'; cgf, jw, mgp, rd, rup, sgp, ssp

Chloris verticillata Nutt. **(38)** BA, LA, MO, OT; 3330–5180'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

Chloris virgata Sw. **(5)** BA, OT; 4250–4910'; mgp, sgp

■ *Cynodon dactylon* (L.) Pers. **(1)** LA; 4440–4440'; rip

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould **(6)** BA, LA; 3970–5530'; mgp, pjw, sgp, ssp

Digitaria californica (Benth.) Henrard **(1)** BA; 4300–4300'; mgp

! *Digitaria pubiflora* (Vasey) Wipff **(2)** BA; 4230–4400'; mgp

Distichlis spicata (L.) Greene **(16)** LA, MO, OT; 3380–4760'; cgf, rip, rd, sbs

■ *Echinochloa crus-galli* (L.) P. Beauv. **(12)** BA, LA, MO, OT; 3290–5940'; rip, rd, stp

Echinochloa muricata (P. Beauv.) Fernald var. *microstachya* Wiegand **(14)** BA, LA, MO, OT; 3340–5770'; rip, stp

Elymus canadensis L. var. *canadensis* **(56)** BA, LA, MO, OT; 3350–6030'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

■ *Elymus elongatus* (Host) Runemark var. *ponticus* (Podp.) Dorn **(1)** OT; 4200–4200'; sgp

Elymus elymoides (Raf.) Swezey var. *brevifolius* (J. G. Sm.) Dorn **(113)** BA, LA, MO, OT; 3200–6090'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp

Elymus glaucus Buckley var. *glaucus* **(11)** BA, LA, MO, OT; 3200–5770'; jw, mgp, rup, sgp, ssp

■ *Elymus hispidus* (Opiz) Melderis var. *hispidus* **(5)** BA, OT; 4160–4930'; rd, sgp

Elymus lanceolatus (Scribn. & J. G. Sm.) Gould **(6)** BA, OT; 4510–4920'; rup, sgp

Elymus smithii (Rydb.) Gould **(79)** BA, LA, MO, OT; 3200–6090'; cgf, jw, mgp, pjw, rd, rup, sbs, sgp, ssp

■ *Eragrostis barrelieri* Daveau **(4)** BA, MO; 3290–4820'; mgp, ssp

■ *Eragrostis cilianensis* (All.) Vignolo ex Janch. **(13)** BA, LA, MO, OT; 3480–5860'; mgp, rip, rd, sgp, ssp, stp

Eragrostis curtipedicellata Buckley **(3)** BA, MO; 3380–4400'; cgf, mgp, sgp

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *miserrima* (E. Fourn.) Reeder **(1)** OT; 4620–4620'; rup

Eragrostis pilosa (L.) P. Beauv. **(3)** BA, MO; 3301–4587'; ssp

Eragrostis trichodes (Nutt.) A.W. Wood **(2)** LA; 5860–5860'; sgp

Eriochloa contracta Hitchc. **(1)** OT; 4650–4650'; rd

Erioneuron pilosum (Buckley) Nash **(50)** BA, LA, MO, OT; 3380–5560'; cgf, jw, mgp, pjw, rup, sgp, ssp
Glyceria striata (Lam.) Hitchc. **(3)** LA; 5530–6090'; rip
Hesperostipa comata (Trin. & Rupr.) Barkworth var. *comata* **(35)** BA, LA, MO, OT; 3380–5980'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Hesperostipa neomexicana (Thurb. ex J.M. Coult.) Barkworth **(22)** BA, LA, OT; 4240–5560'; rup, sgp
Hilaria jamesii (Torr.) Benth. **(78)** BA, LA, MO, OT; 3420–5240'; mgp, pjw, rd, rup, sgp
Hopia obtusa (Kunth) Zuloaga & Morrone **(36)** BA, LA, MO, OT; 3350–6130'; cgf, mgp, pjw, rd, rup, sgp, ssp
Hordeum brachyantherum Nevski **(1)** LA; 5470–5470'; rd
Hordeum jubatum L. ssp. *intermedium* Bowden **(36)** LA, MO, OT; 3420–5900'; mgp, pjw, rip, rd, sgp
Hordeum jubatum L. ssp. *jubatum* **(1)** BA; 4800–4800'; sgp
Hordeum pusillum Nutt. **(32)** BA, LA, MO, OT; 3380–6030'; cgf, jw, mgp, rd, rup, sgp, ssp
Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow **(8)** LA, MO, OT; 3340–6130'; rip, rd
Lycurus setosus (Nutt.) C. Reeder **(4)** BA, LA, OT; 4340–5370'; jw, mgp, pjw
Muhlenbergia arenacea (Buckley) Hitchc. **(4)** LA, OT; 4400–4550'; jw, sbs, sgp
Muhlenbergia arenicola Buckley **(5)** BA, LA, OT; 4090–5600'; jw, rd, sgp
Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi **(10)** LA, MO, OT; 3370–5770'; rip, sbs, sgp
Muhlenbergia racemosa (Michx.) Britton, Sterns, & Poggenb. **(1)** OT; 4930–4930'; rip
Muhlenbergia torreyi (Kunth) Hitchc. ex Bush **(18)** BA, LA, OT; 3200–5380'; mgp, pjw, rup, sgp, ssp *Munroa squarrosa* (Nutt.) Torr. **(21)** BA, LA, MO, OT; 3290–6060'; jw, mgp, pjw, rd, rup, sgp, ssp
Nassella viridula (Trin.) Barkworth **(9)** LA, OT; 4990–6090'; pjw, rd, rup, sgp
Panicum capillare L. ssp. *capillare* **(16)** BA, MO, OT; 3380–5190'; cgf, mgp, pjw, rup, sgp, ssp
Panicum hallii Vasey **(1)** BA; 4250–4440'; jw
Panicum virgatum L. **(20)** BA, LA, MO, OT; 3290–5530'; cgf, mgp, pjw, sgp, ssp
■ *Paspalum racemosum* Lam. **(2)** LA, MO; 3330–5370'; jw, ssp
Paspalum setaceum Michx. var. *stramineum* (Nash) D. J. Banks **(4)** BA, MO; 3350–4310'; rup, ssp
Phalaris arundinacea L. **(1)** MO; 3410–3410'; cgf
Phalaris caroliniana Walter **(1)** BA; 4340–4350'; rip
Piptatherum micranthum (Trin. & Rupr.) Barkworth **(14)** BA, LA, OT; 4310–6210'; jw, pjw, rup
■ *Poa compressa* L. **(8)** BA, LA, MO, OT; 3550–6440'; pjw, rup
Poa fendleriana (Steud.) Vasey **(1)** OT; 4400–4400'; sgp
■ *Poa pratensis* L. **(1)** LA; 5740–5740'; sgp
Polypogon monspeliensis (L.) Desf. **(25)** BA, LA, MO, OT; 3340–5420'; mgp, pjw, rip, rup, ssp, stp
Polypogon viridis (Gouan) Breistr. **(3)** BA, LA; 4250–5130'; rip
■ *Puccinellia distans* (L.) Parl. **(1)** LA; 4690–4690'; rip
Schedonnardus paniculatus (Nutt.) Trel. **(87)** BA, LA, MO, OT; 3200–6080'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
■ *Schedonorus arundinaceus* (Schreb.) Dumort. **(4)** BA, LA, MO, OT; 3380–5370'; rup
Schizachyrium scoparium (Michx.) Nash var. *scoparium* **(10)** BA, LA, OT; 4420–6210'; mgp, pjw, rup
Setaria leucopila (Scribn. & Merr.) K. Schum. **(2)** LA; 4500–4950'; jw, sgp
■ *Setaria pumila* (Poir.) Roem. & Schult. **(8)** LA, MO, OT; 3300–5030'; rip, rup, sgp, ssp
Setaria viridis (L.) P. Beauv. **(10)** BA, LA, OT; 4150–5860'; jw, rd, rup, sgp, ssp
Sorghastrum nutans (L.) Nash **(2)** BA; 4300–4300'; mgp
Sorghum bicolor (L.) Moench **(2)** LA, OT; 4220–5940'; jw, sgp
Sorghum halepense (L.) Pers. **(8)** LA, MO, OT; 3330–5030'; rip, sgp, ssp
Spartina pectinata Link **(1)** OT; 4300–4300'; rip
Sphenopholis obtusata (Michx.) Scribn. **(2)** BA, OT; 4260–4930'; mgp
Sporobolus airoides (Torr.) Torr. **(37)** LA, MO, OT; 3380–6130'; cgf, jw, mgp, pjw, rd, rup, sbs, sgp, ssp
Sporobolus contractus Hitchc. **(1)** BA; 4910–4910'; mgp
Sporobolus cryptandrus (Torr.) A. Gray **(42)** BA, LA, MO, OT; 3200–5940'; cgf, jw, mgp, rd, rup, sgp, ssp
Sporobolus texanus Vasey **(1)** BA; 4260–4260'; mgp
Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners **(10)** LA, OT; 4300–4990'; jw, rup, sgp
Triticum aestivum L. **(15)** BA, LA, OT; 4290–6050'; pjw, rup, rd, sgp
Vulpia octoflora **(9)** BA, MO, OT; 3380–4770'; cgf, mgp, rup, sgp, ssp

Polemoniaceae
Gilia ophthalmoides Brand **(4)** OT; 4290–4800'; mgp, pjw, rup
Giliastrum acerosum (A. Gray) Rydb. **(32)** LA, OT; 4300–4990'; jw, mgp, rup, sgp
Ipomopsis laxiflora (J.M. Coult.) V.E. Grant **(15)** BA, LA, OT; 4222–5740'; jw, mgp, rup, sgp, ssp
Ipomopsis pumila (Nutt.) V.E. Grant **(4)** LA, OT; 4470–4580'; jw, sgp
Microsteris gracilis (Dougl. ex Hook.) Greene var. *humilior* (Greene) H. Mason **(1)** LA; 5740–5740'; sgp
Phlox longifolia Nutt. ssp. *longifolia* **(6)** OT; 4500–4800'; jw, mgp, rup

Polygalaceae
Polygala alba Nutt. **(16)** BA, LA, MO, OT; 3410–5120'; jw, mgp, pjw, rip, rup, sgp, ssp

Polygonaceae
Eriogonum annuum Nutt. **(21)** BA, LA, MO, OT; 3370–5370'; mgp, pjw, rup, sgp, ssp
Eriogonum gordonii Benth. **(2)** OT; 4540–4770'; rup
Eriogonum jamesii Benth. var. *jamesii* **(20)** BA, LA, OT; 4220–6210'; mgp, pjw, rup
Eriogonum lachnogynum Torr. ex Benth. var. *lachnogynum* **(41)** BA, LA, MO, OT; 3410–6210'; mgp, pjw, rup, sgp, ssp
Eriogonum lonchophyllum Torr. & A. Gray **(2)** OT; 4500–4940'; jw, sgp
Eriogonum microthecum Nutt. var. *effusum* (Nutt.) Torr. & A. Gray **(7)** LA, OT; 4330–5240'; jw, sgp
Eriogonum tenellum Torr. var. *tenellum* **(45)** BA, LA, OT; 3970–5560'; mgp, pjw, rup, sgp, ssp
■ *Fallopia convolvulus* (L.) Á. Löve **(1)** MO; 3360–3360'; cgf
Persicaria amphibia (L.) Gray **(1)** LA; 5100–5100'; rip
Persicaria bicornis (Raf.) Nieuwl. **(2)** BA; 4300–4750'; rip, stp
■ *Persicaria lapathifolia* (L.) Gray **(5)** LA, MO; 3370–4410'; rip
■ *Polygonum aviculare* L. **(38)** BA, LA, MO, OT; 3200–6130'; pjw, rip, rup, sgp, ssp, stp
Polygonum ramosissimum Michx. var. *ramosissimum* **(16)** BA, LA, MO, OT; 3330–5860'; rip, rd, rup, sgp, ssp, stp
Rumex altissimus A.W. Wood **(7)** BA, LA, MO, OT; 3490–5320'; rip
■ *Rumex crispus* L. **(13)** BA, LA, OT; 4160–6080'; rip, stp
Rumex patientia L. **(1)** LA; 4440–4440'; rip
■ *Rumex stenophyllus* Ledeb. **(1)** LA; 4870–4870'; rip

Portulacaceae
Phemeranthus parviflorus (Nutt.) Kiger **(3)** BA, LA, OT; 4140–5100'; rup, sgp
Portulaca halimoides L. **(1)** LA; 5770–5770'; rip
Portulaca oleracea L. **(3)** LA, OT; 4540–6130'; sgp, stp

Potamogetonaceae
Potamogeton foliosus Raf. var. *foliosus* **(1)** LA; 4480–4480'; rip

Stuckenia filiformis (Pers.) Börner ssp. *occidentalis* (J.W. Robbins) R.R. Haynes, Les, & M. Král **(1)** OT; 4540–4540'; rip
Stuckenia pectinata (L.) Börner **(4)** LA, MO; 3370–6030'; rip
Zannichellia palustris L. **(3)** LA, OT; 4310–5110'; rip

Ranunculaceae
Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks **(18)** BA, MO, OT; 3310–5150'; cgf, mgp, pjw, rup, sgp, ssp
Ranunculus cymbalaria Pursh **(1)** BA; 4300–4300'; rip
Ranunculus hyperboreus Rottb. **(1)** BA; 4900–4900'; rip
Ranunculus sceleratus L. var. *multifidus* Nutt. **(6)** BA, LA; 4260–5140'; rip
Ranunculus sceleratus L. var. *sceleratus* **(2)** BA; 4250–4250'; rip

Rhamnaceae
Ceanothus herbaceus Raf. **(1)** MO; 3410–3410'; ssp

Rosaceae
Cercocarpus montanus Raf. var. *montanus* **(15)** LA, OT; 4320–6060'; jw, pjw, rup, sgp
■ *Malus pumila* Mill. **(2)** BA, LA; 4370–5600'; jw, rd
Physocarpus monogynus (Torr.) J.M. Coult. **(4)** LA; 5140–6050'; pjw, sgp
Potentilla pensylvanica L. **(1)** LA; 5560–5560'; sgp
Potentilla rivalis Nutt. var. *millegrana* (Engelm. ex Lehm.) S. Watson **(5)** LA, OT; 4500–5740'; pjw, sgp
Prunus americana Marshall **(3)** BA, LA; 4050–5450'; jw, rip, rd, sgp
○ *Prunus angustifolia* Marshall var. *angustifolia* **(5)** BA, LA, MO, OT; 3520–5550'; rd, rup, sgp, ssp
■ *Prunus cerasus* L. **(1)** LA; 5110–5110'; rip
Prunus pensylvanica L. f. **(1)** LA; 5110–5110'; rip
Prunus virginiana L. var. *melanocarpa* (A. Nelson) Sarg. **(3)** LA, OT; 4310–6080'; pjw, rip
Rosa arkansana Porter var. *arkansana* **(1)** LA; 4450–4450'; rip
Rubus deliciosus Torr. **(6)** BA, LA; 4230–6090'; jw, pjw, rip
■ *Spiraea trilobata* L. **(1)** BA; 4630–4630'; rd

Rubiaceae
■ *Galium aparine* L. **(1)** MO; 3360–3360'; cgf

Rutaceae
Ptelea trifoliata L. **(11)** LA, OT; 4350–6440'; jw, pjw, rip

Salicaceae
× *Populus* ×*acuminata* Rydb. **(2)** LA, OT; 5100–5770'; rip
■ *Populus alba* L. **(1)** LA; 5470–5470'; rd
Populus deltoides W. Bartram ex Marshall var. *occidentalis* Rydb. **(46)** BA, LA, MO, OT; 3360–5900'; cgf, rip, rd, stp
Salix amygdaloides Andersson **(15)** BA, LA, MO, OT; 3490–6090'; rip
× *Salix amygdaloides* Andersson × *Salix nigra* Marshall **(1)** BA; 4280–4280'; rip
Salix exigua Nutt. ssp. *exigua* **(20)** BA, LA, MO, OT; 3350–5770'; rip
Salix exigua Nutt. ssp. *interior* (Rowlee) Cronquist **(8)** BA, LA, MO, OT; 3370–5110'; rip
Salix nigra Marshall **(1)** MO; 3350–3350'; rip

Santalaceae
Comandra umbellata (L.) Nutt. var. *pallida* (A. DC.) M.E. Jones **(7)** OT; 4380–4800'; jw, mgp, rup

Sapindaceae
Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson **(10)** BA, LA, OT; 4250–4980'; cgf, mgp, pjw, rip, rup, sgp

Sarcobataceae
Sarcobatus vermiculatus (Hook.) Torr. **(5)** LA, OT; 4510–5120'; jw, pjw, rup, sbs

Scrophulariaceae
■ *Verbascum thapsus* L. **(19)** BA, LA, OT; 3970–6030'; mgp, pjw, rd, sgp, ssp, stp

Solanaceae
Chamaesaracha coniodes (Moric. ex Dunal) Britton **(18)** BA, LA, MO, OT; 3530–4980'; jw, mgp, pjw, rd, rup, sgp
Chamaesaracha coronopus (Dunal) A. Gray **(3)** BA, OT; 4480–4730'; jw, sgp
Physalis hederifolia A. Gray var. *comata* (Rydb.) Waterf. **(17)** BA, LA, MO, OT; 3340–6090'; jw, pjw, rd, rup, sgp, ssp
Physalis hederifolia A. Gray var. *fendleri* (A. Gray) Cronquist **(1)** OT; 4290–4390'; pjw
Physalis hispida (Waterf.) Cronquist **(38)** BA, LA, MO, OT; 3270–5170'; cgf, jw, mgp, rd, rup, sgp, ssp
Physalis longifolia Nutt. **(19)** BA, LA, MO, OT; 3340–5860'; cgf, pjw, rd, rup, sgp
Physalis virginiana Mill. **(3)** MO, OT: 3410–4356'; jw, ssp
Quincula lobata (Torr.) Raf. **(35)** BA, LA, MO, OT; 3660–6030'; jw, mgp, rd, rup, sgp, ssp
Solanum americanum Mill. **(4)** BA, MO; 3380–4300'; cgf, mgp, rup
Solanum elaeagnifolium Cav. **(32)** BA, LA, MO, OT; 3340–6210'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Solanum rostratum Dunal **(44)** BA, LA, MO, OT; 3290–6130'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Solanum triflorum Nutt. **(1)** OT; 4300–4300'; rd

Tamaricaceae
■ *Tamarix ramosissima* Ledeb. **(40)** LA, MO, OT; 3310–6130'; cgf, rip, sbs, stp

Typhaceae
Typha angustifolia L. **(3)** BA, LA, OT; 4540–5470'; rip, stp
× *Typha angustifolia* L. × *Typha domingensis* Pers. **(2)** LA, OT; 4560–5100'; rip, stp
Typha domingensis Pers. **(10)** LA, MO, OT; 3380–5770'; rip, stp

Ulmaceae
Ulmus americana L. **(7)** BA, LA, MO, OT; 3200–4870'; jw, rip, rd, sgp
■ *Ulmus parvifolia* Jacq. **(1)** LA; 5810–5810'; rd
■ *Ulmus pumila* L. **(13)** BA, LA, MO, OT; 3620–5960'; jw, mgp, rd, rup, sgp, ssp
Ulmus rubra Muhl. **(1)** LA; 5470–5470'; rd

Urticaceae
Parietaria pensylvanica Muhl. ex Willd. **(2)** LA, OT; 4930–5560'; jw, rip

Verbenaceae
Glandularia bipinnatifida (Nutt.) Nutt. var. *bipinnatifida* **(60)** BA, LA, MO, OT; 3350–5980'; jw, mgp, pjw, rd, rup, sgp, ssp
Phyla cuneifolia (Torr.) Greene **(3)** BA, OT; 4280–4760'; mgp, rip, sgp, stp
Verbena bracteata Lag. & Rodr. **(110)** BA, LA, MO, OT; 3200–6130'; cgf, jw, mgp, pjw, rd, rup, sgp, ssp
Verbena hastata L. **(4)** BA, LA; 4300–5530'; mgp, pjw, sgp

Violaceae
Hybanthus verticillatus (Ortega) Baill. **(8)** LA, MO, OT; 3530–5900'; jw, mgp, rup, sgp
Viola nuttallii Pursh **(7)** LA, OT; 4410–5740'; jw, mgp, rup, sgp

Vitaceae
Parthenocissus quinquefolia (L.) Planch. **(1)** LA; 5100–5100'; jw
Parthenocissus vitacea (Knerr) Hitchc. **(8)** BA, LA, OT; 4160–6090'; jw, pjw
Vitis acerifolia Raf. **(13)** BA, LA; 4250–5530'; cgf, mgp, pjw, rip, rup

Zygophyllaceae
Kallstroemia parviflora Norton **(1)** LA; 4870–4870'; rd
Krameria lanceolata Torr. **(9)** BA, MO; 3430–4870'; mgp, rup, sgp, ssp
■ *Tribulus terrestris* L. **(32)** BA, LA, MO, OT; 3330–5960'; rd, sgp

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A CHECKLIST OF THE LIVERWORTS (MARCHANTIOPHYTA) AND HORNWORTS (ANTHOCEROTOPHYTA) OF FLORIDA

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ABSTRACT

A study of the literature and collections in herbaria yields 27 families, 53 genera, and 167 species and infraspecies of hepatics and hornworts (Marchantiophyta and Anthocerotophyta) from the state of Florida. Most species (44%) have distributions in the Northern Hemisphere, 42% tropical, 10% widespread, and 4% endemic to Florida. Twenty-four dubious and excluded taxa are listed.

RESUMEN

Basados en una revisión bibliográfica y de especímenes de herbario los autores proponen la presencia de 27 familias, 53 géneros y 167 especies de hepáticas (Marchantiophyta y Anthocerotophyta) para el estado de Florida. La mayor parte de las especies citadas (44%) están distribuidas en el Hemisferio Norte, 42% son tropicales, 10% de amplia distribución y 4% son endémicas para el Estado de Florida. Se enumeran 24 taxones dudosos o excluidos.

INTRODUCTION

Based on specimens in the New York Botanical Garden and the University of Florida herbaria, the first person known to have collected a hepatic in Florida was John Torrey who collected *Pallavicinia lyellii* along the St. Johns River in March 1871. Subsequently, Edward Palmer collected the same species along the Indian River in 1874. In November 1877, Abram P. Garber also collected this species and several others near Rosewood, Levy County. Garber came to Florida from his native Pennsylvania in 1876 to arrest his tuberculosis. This not being successful, he returned to Pennsylvania in June 1881 where he died about two months later. In 1877, John Donnell Smith, Coe Finch Austin, and Lucian Marcus Underwood began actively collecting in the state.

The first resident collector was Severin Rapp (1853–1941), a German immigrant and shoemaker, living in Sanford, Seminole County, who following his retirement, devoted his time to collecting botanical specimens. Rapp also collected flowering plants, but his primary interests were bryophytes (Wunderlin & Hansen 2000). His bryophyte collections are deposited in the herbarium at the Florida Museum of Natural History (FLAS).

The first published report of a hornwort from Florida was by Coe Finch Austin (1875) who reported *Anthoceros punctatus* var. *eatonii* collected by Daniel Cady Eaton and *Anthoceros olneyi* collected by Stephen T. Olney. Austin (1877) then described *Riccia donnellii* and *Sphaerocarpus donnellii*, both collected by John Donnell Smith in Florida. Later Austin (1879) described *Frullania donnellii* also collected by John Donnell Smith in 1877 in Florida and *Radula caloosiensis* and *Anthoceros donnellii* that he collected in 1878. He also mentioned several other species from the state. In addition, Franz Stephani (1892) described *Lejeunea underwoodii* collected by Lucien M. Underwood and Orator Fuller Cook in Florida.

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Major 20th Century bryophyte collectors in the state of Florida include Ruth Schornherst Breen, Elizabeth G. Britton, James B. McFarlin, A.J. Grout, Otto E. Jennings, Rex L. Lowe, Paul L. Redfearn, Herman Kurz, Aaron "Jack" Sharp, John K. Small, Rudolph M. Schuster, Herman Kurz, and Thomas M. Little.

The first major hepatic work was by Alexander William Evans (1902) who described 27 species of Lejeuneaceae from Florida. Evans (1918) added six more Lejeuneaceae, including four new species. He enumerated 44 species of Lejeuneaceae from Florida, from a total of 48 species known from the United States. Based on Severin Rapp collections from 1904 to 1914, Caroline C. Haynes (1915) reported 64 hepatic species, 24 in the Lejeuneaceae.

Although several local inventories were completed, e.g., Kurz and Little (1933) for north and central Florida and Redfearn (1952) for central and southern Florida, no comprehensive list of the hepatics of Florida has been made since that of McFarlin (1940) who reported 136 species and four varieties in 51 genera. McFarlin's Florida collections are deposited at the Florida Museum of Natual History (FLAS) with a smaller number in other herbaria, e.g., the Canadian Museum of Nature, Bryophyte Section (CANM) (Palmer 2006). A significant contribution to our knowledge of the liverworts of the Mid-gulf coastal plain (including the central and eastern panhandle and northeast peninsular Florida) is by the late David Breil (1970). He reported 107 species in 49 genera, which he claimed to have based on 5,000 specimens collected between 1965 and 1968. From the species reported by Breil, over 50% are tropical and subtropical, 45% widespread temperate, and 5% are endemic (see also Biogeographic analysis below). No specimen citations are given by Breil (1970), but specimens were allegedly deposited at Longwood University (FARM) with representative duplicates at DUKE, FLAS, NY and US (Breil 1970).

The Florida Museum of Natural History in Gainesville (FLAS) contains an outstanding bryophyte collection with an estimated 160,000 specimens (Perkins, pers. comm.), the great majority composed of mosses. It contains representative modern collections such as those of Dana Griffin III's starting in the late 1960s. The Hepatic collection contains significant historical collections sets such as those of Rapp and McFarlin which make this collection an essential source for the study of the bryophyte diversity in Florida. Since the early 1980s, significant collections now deposited at the University of South Florida (USF), were made by Rita and James Lassiter.

Based on the amount of literature and availability of modern and historical collections of Marchantiophyta and Anthocerotophyta in public herbaria in the United States, Florida can be considered a well known floristic province, in comparison with other subtropical or tropical areas. However, this information has not been compiled into a single document until now.

MATERIALS AND METHODS

The list was prepared based primarily on examination of herbarium specimens in the Florida Museum of Natural History (FLAS), the University of South Florida (USF), and the New York Botanical Garden (NY) herbaria, and from the literature. When a herbarium specimen revised by the first author is cited, its herbarium accession number is included (e.g., FLAS-B061974). Except for Lejeuneaceae and other selected taxa, identifications given on the specimen labels were largely accepted. The primary literature examined is Haynes (1915), Kurz and Little (1933), Frye and Clark (1937, 1943, 1945, 1946, 1947), Redfearn (1952), Breil (1970), and Schuster (1966, 1969, 1974, 1980, 1992a, 1992b). The 21 hepatic records published in Herring and Judd (1995) are not included because no voucher specimens were found and specific county locality information is lacking. When a type was collected in Florida, the protologue is entirely cited. The genera are assigned to their corresponding families following Crandall-Stotler et al. (2009).

RESULTS

Biogeographical analysis.—In our analysis, the categories or biogeographic elements are simplified due to the lack of floristic and monographic treatments available on a worldwide scale and the sometimes conflicting distributional data in the literature. Four major groups are here recognized among the hepatics of Florida: Northern Hemisphere, Tropical, Endemic, and Widespread.

Northern Hemisphere Element.—This element is basically holarctic in its classical definition and accounts for 44% of the taxa in Florida. It includes the Conocephalaceae (with *Conocephalum salebrosum* in Florida), a family completely absent in the New World tropics. It also includes species with genera well represented in the neotropics, such as *Calypogeia*, *Plagiochila*, and *Radula*, with a series of species occurring only in temperate areas (e.g., *Calypogeia neogaea*, *C. sullivantii*). Other taxa such as Rebouliaceae (*Reboulia hemispherica*) and Sphaerocarpaceae (*Sphaerocarpos donnellii*, *S. texanus*) are confined to the outer, southern and northern limits of the neotropics (Gradstein et al. 2001).

Tropical Element.—This includes taxa that are neotropical or pantropical and accounts for 42% of the taxa in Florida. Taxa of the predominantly tropical family Lejeuneaceae, which represents 34% of the taxa in Florida, accounts for 26% of the tropical element which makes this family of major importance in the local diversity. Most members of this family in Florida are rather common and widespread species in the neotropics. Lejeuneaceae also account for half of the endemic species known from Florida. Several genera which are speciose in tropical mountain areas are rather poor in Florida. This is the case of the genera *Lepidozia* and *Bazzania*, the former with no records and the latter with only one species, *B. trilobata* reported from the state.

Endemic Element.—Florida has a high number of endemic plant species. For example, of the 4,255 known taxa of vascular plants, 229 (5%) are endemic (Wunderlin & Hansen 2011). Although much fewer in total number (167), seven hepatics (4%) are similarly endemic to the state. Endemic hepatics in Florida include: *Cheilolejeunea polyantha*, *Cololejeunea subcristata*, *Frullania sabaliana*, *Frullania taxodiocola*, *Lejeunea minutiloba* var. *heterogyna*, *Plagiochila invisa*, and *Riccardia stricta*. Forty-three percent of the endemic species belong to the family Lejeuneaceae.

Widespread Element.—This includes taxa that are cosmopolitan, subcosmopolitan, or are basically northern or southern hemispheres but have extensive ranges into another part of the world. Ten percent of the Florida taxa fall into this category.

The relative equal richness of the tropical and northern hemisphere elements in the hepatic flora of Florida suggests that the area is a confluence of both elements. It should be expected that the southernmost distribution limits of temperate elements and the northernmost distribution limits of tropical lowland and mid-elevation species would occur in the state. The predominantly tropical family Lejeuneaceae shows greatest importance in the local diversity, accounting for 34% of the total taxa. This is followed by the Frullaniaceae (9%), the Ricciaceae (8%), and the Plagiochilaceae (5%).

ANNOTATED LIST OF LIVERWORTS AND HORNWORTS

MARCHANTIOPHYTA

ANEURACEAE

Aneura maxima (Schiffn.) Steph.

Gadsden Co.: Glen Julia, just S of Mount Pleasant, beech-*Magnolia* ravine, 23 Sep 1943, *Breen 2180* (DUKE, archegoniate specimen det. P.G. Davison Dec 2010, Breil 1970 as *Blasia pusilla* L.).

Aneura pinguis (L.) Dumort.

Riccardia pinguis (L.) Gray

Alachua Co.: Devil's Millhopper, 29 Apr 1972, *Buck s.n.* (NY); along run on the N side of Gainesville, *Little s.n.* (Kurz & Little 1933; Frye & Clark 1937). **Bay Co.:** Breil (1970); Schuster (1992a). **Calhoun Co.:** Breil (1970); Schuster (1992a). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, on rotting wood in low hammock, 3 Apr 1980, Lassiter *et al. 381* (USF). **Collier Co.:** Fahkahatchee Strand, 6 mi NW of Copeland, on stump in dense, low tropical hammock with royal palms, 26 Oct 1963, *Lassiter et al. s.n.* (USF). **Dixie Co.:** Breil (1970); Schuster (1992a). **Gadsden Co.:** Midway cutoff, off US 90, W of Tallahassee, 20 Jun 1945, Breen 2290 (NY); Breil (1970); Schuster (1992a). **Highlands Co.:** Sebring, 1936, *McFarlin 1324* (Frye & Clark 1937; Schuster 1992a). **Hillsborough Co.:** upper Hillsborough River at Cowhouse Slough, 15 Sep 1984, *Lassiter & Lassiter 2025* (USF). **Hernando Co.:** Chassahowitzka swamp, off Swamp Grade, on rotting wood in a coastal swamp, T21S, R17E, Sec. 15, 12 Apr 1996, *vanHoek et al.* 523 (USF). **Jackson Co.:** Breil (1970); Schuster (1992a). **Jefferson Co.:** 4 mi SW of Flint Rock, *Kurz s.n.* (Kurz & Little 1933); W of Aucilla River, Rte. 98, *Schuster 44200* (Schuster 1992a). **Lake Co.:** Tavares, 20 Jan 1891, *Underwood 1532* (NY); Alexander Springs, Ocala National Forest, *Schuster 33421* (Schuster 1992a); Tavares, *Underwood*

s.n. (Schuster 1992a). **Lee Co.:** near Lake Trafford *McFarlin & Grout 1000* (Schuster 1992a). **Leon Co.:** Caldwell's Woods, Tallahassee, base of stump, 20 Feb 1952, *Jackson 25LW* (NY); 4 mi from Tallahassee, on Old Spanish Trail, *Kurz s.n.* (Kurz & Little 1933); Breil (1970); Schuster (1992a). **Liberty Co.:** Rock Bluff below Torreya State Park along Apalachicola River, over rotten moist log, 17 Jan 1968, *Breil 2407* (NY); Breil (1970); Schuster (1992a). **Martin Co.:** in coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3585* (USF). **Monroe Co.:** Rodgers River, hammock, 6 Apr 1916, *Small 7559* (NY); *Taxodium ascendens* swamp, between Ochopee and Monroe Station, *Schuster 42244* (Schuster 1992a). **Palm Beach Co.:** Kelsey City, cypress head, 16 Dec 1920, *Small et al. 9819* (NY). **Pasco Co.:** near Fivay Junction on SR 52, on rotting wood in low hammock with creek, 15 Mar 1981, Lassiter *& Lassiter 552* (USF). **Seminole Co.:** Sanford, on rotten logs in swamp, Jan 1914, *Rapp* 28 (NY, Haynes 1915); Schuster (1992a). **Volusia Co.:** Port Orange, 14 Feb 1895, *Straub 192* (NY). **Wakulla Co.:** Wakulla Swamp, 12 Feb 1944, *Breen 2241* (NY); *Schornherst 2241* (Schuster 1992a); Breil (1970).

Riccardia chamedryfolia (With.) Grolle

Liberty Co.: Torreya State Park, Apalachicola River, *Schuster 44046* (Schuster 1992a).

Riccardia multifida (L.) Gray

Alachua Co.: Devil's Millhopper, NW of Gainesville, *Schuster 33498, 33477* (Schuster 1992a). **Baker Co.:** Breil (1970). **Bay Co.:** Breil (1970). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, on rotting wood with mosses, in marshy border of hammock island, 3 Apr 1980, Lassiter *et al. 384* (USF). **Columbia Co.:** Breil (1970). **Duval Co.:** Goodby's Lake, adjacent to St. Johns River, decaying log, 2 Apr 1977, *Grey s.n.* (USF). **Gadsden Co.:** Glen Julia, *Schornherst 2270* (Schuster 1992a); Breil (1970). **Hernando Co.:** 3–4 mi NW of Brooksville, hammock forest, *Schuster 22106* (Schuster 1992a). **Highlands Co.:** Sebring, 1936, *McFarlin 1323* (Frye & Clark 1937). **Holmes Co.:** Breil (1970). **Jackson Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Liberty Co.:** Torreya State Park on Apalachicola River, common on rotting wood along trail, 1 Sep 1984, *Lassiter et al. 2034* (USF); Torreya State Park, Apalachicola River, *Schuster 44042, 44093* (Schuster 1992a); Breil (1970). **Marion Co.:** Juniper Springs Creek, 1.3 mi downstream from Juniper springs, T15S, R26E, Sec. 16, SE 1/4 of SW 1/4, low woods along creek bank, in full shade, 4 May 1979, Hansen & Richardson 5455 (USF); Juniper Springs, 4–5 mi below Juniper Springs, Ocala National Forest, *Schuster 33400b* (Schuster 1992a); Juniper Springs, *Schuster 22475* (Schuster 1992a); Silver Glen Springs, *Schuster 42200, 42203, 42205* (Schuster 1992a). **Miami-Dade Co.:** Redfearn (1952); Schuster (1992a). **Orange Co.:** Rock Springs Run, 7 mi N of Apopka, on rotting wood at water's edge, 23 May 1982, Lassiter *et al. 633* (USF). **Pasco Co.:** SR 54, 1.5 mi W of I-75, near Quail Hollow, on rotting wood at base of *Osmunda regalis* in cut-over, partially open swamp, 27 Jan 1981, Lassiter *& Lassiter 499* (USF). **Polk Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Putnam Co.:** N of Orange Springs, S edge of Putnam Co., *Schuster 42210* (Schuster 1992a). **Seminole Co.:** Sanford, on logs in wet places, *Rapp 26* (Haynes 1915, Frye & Clark 1937); McFarlin (1940); Redfearn (1952); Schuster (1992a).

Riccardia multifida subsp. **synoica** R.M. Schust.

Hernando Co.: Hammock forest, 3–4 mi NW of Brooksville, *Schuster 22106* (Schuster 1992a). **Lake Co.:** Alexander Springs, Ocala National Forest, *Schuster 33435a, 33426a* (Schuster 1992a). **Marion Co.:** Juniper Springs, *Schuster 22475* (Schuster 1992a); Silver Glen Springs, *Schuster 42191* (Schuster 1992a.

Riccardia palmata (Hedw.) Carruth.

Alachua Co.: along creek S of Athletic Field, Gainesville, *Little s.n.* (Kurz & Little 1933). **Leon Co.:** Tallahassee, 3 mi along road to Quincy, *Kurz s.n.* (Kurz & Little 1933). **Polk Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Seminole Co.:** Sanford, on rotten logs, *Rapp 27* (Haynes 1915); Frye & Clark (1937); Redfearn (1952); Schuster (1992a).

Riccardia stricta R.M. Schust., J. Hattori Bot. Lab 62:326. 1987. TYPE: FLORIDA. CLAY CO.: Gold Head Branch State Park, 29 Dec 1955, *Schuster 37212*.

Liberty Co.: Torreya State Park, Rock Creek, *Schuster 44081, 44093, 44096* (Schuster 1992a). **Putnam Co.:** 1 mi N of Orange Springs, S edge of County, swampy woods, *Schuster 42213* (Schuster 1992a).

CALYPOGEIACEAE

Calypogeia neogaea (R.M. Schust.) Bakalin

Calypogeia fissa subsp. *neogaea* R.M. Schust.

Bay Co.: Breil (1970). **Citrus Co.:** Homosassa Springs, in wet shade, growing on tree roots, 22 Feb 1955, [*Breil*] *1476B* (NY). **Gadsden Co.:** Crooked River, on very wet soil, 4 May 1940, *Breen 824* (NY); Breil (1970). **Jackson Co.:** Breil (1970). **Jefferson Co.:** 14 mi E of Tallahassee on US 27, on moist sandy ravine bank, oak-shortleaf pine forest, 24 Nov 1967, *Breil 2130* (NY); Breil (1970). **Leon Co.:** Tallahassee, Caldwell's Woods off Old Bainbridge Road, plants on inner side of gutted stump, 13 Feb 1967, *Breil 1425* (NY). **Liberty Co.:** Bluff over Apalachicola River, Torreya State Park, *Schuster 44042a* (paratype, Schuster 1969); ravine cut into Alum Bluff, Apalachicola River, *Schuster 335[illegible]* (Schuster 1969); state park, 1937, *McFarlin 1482* (Frye & Clark 1946); Breil (1970). **Seminole Co.:** McFarlin (1940); Redfearn (1952). **Wakulla Co.:** Breil (1970). **Walton Co.:** Breil (1970).

The type is from Lee Co., Mississippi not Florida. Schuster mentions Florida material after citing the type. Except for the Schuster specimens, the records reported above were published as *Calypogeia fissa*.

Calypogeia peruviana Nees & Mont.

Bay Co.: 3.2 mi N of Fountain on US 231, along stream, in moist *Nyssa*-sweetgum hardwoods, on peaty soil over root, 14 Oct 1967, *Breil 2057* (NY). **Hernando Co.:** 2 mi W of Brooksville, T22S, R19E, Sec. 10, on bank of seepage slope in low hammock, 15 Nov 1980, Lassiter & *Lassiter 555* (USF). **Hillsborough Co.:** Alderman's Ford Park, low hammock, 14 Jun 1981, Lassiter & *Lassiter 654* (USF). **Lake Co.:** headwaters of St. Johns River, Juniper Springs, Ocala National Forest, *Schuster 33435, 33435a* (Schuster 1969). **Liberty Co.:** Torreya State Park, *Schuster s.n.* (Schuster 1969). **Seminole Co.:** Sanford, Mar 1923, *Rapp 93* (Schuster 1969). **Wakulla Co.:** ca. 8 mi W of Sopchoppy on S-375, 1 Feb 1968, *Breil 2452* (NY).

Calypogeia sullivantii Austin

Calypogeia arguta Nees & Mont. ex Nees var. *sullivantii* (Austin) Frye & L. Clark

Leon Co.: Breil (1970). **Liberty Co.:** Torreya State Park, *Schuster 44042a* (Schuster 1969). **Seminole Co.:** Sanford, on ditch bank, *Rapp 53* (Haynes 1915); McFarlin (1940); Redfearn (1952); *Rapp s.n.* (Kurz & Little 1933, Frye & Clark 1946).

CEPHALOZIACEAE

Cephalozia bicuspidata (L.) Dumort.

Clay Co.: ca. 0.5 mi E of Rte. 21 on small sand road, T6S, R24E, Sec. 27, moist forest along S fork of Black Creek, on downed, decorticated log, 30 Sep 1983, *Griffin 326* (FLAS). **Seminole Co.:** McFarlin (1940); Redfearn (1952). **Without Co.:** Kurz & Little (1933); Frye & Clark (1945).

Schuster (1974) discredited reports of previous authors, but the specimen held at FLAS belongs to *C. bicuspidata*, and confirms its presence in the southeastern coastal plane. Known as a species distributed in temperate areas of Europe, northern Africa, Asia, & North America, this species has been reported from Costa Rica by Morales (1991) and Dauphin (2005).

Cephalozia catenulata (Huebener) Lindb.

Alachua Co.: Devil's Millhopper, moist rotten log, 21 May 1972, *Buck s.n.* (NY); Gainesville, 1916, *Melwin 128* (Haynes 1915, Frye & Clark 1945, Schuster 1974). **Bay Co.:** Econfina Creek on S-388, along river on W side, 4 Mar 1967, *Breil 1902* (NY). **Clay Co.:** Camp Blanding Training Site, Hog Pen Creek, branch of N fork of Black Creek, at crossing of Black Creek Road, on downed, decorticated trunk, moist, shady, 6 Mar 1999, *Griffin 2666 (CB-490)* (FLAS-B063404). **Gadsden Co.:** S-268 at Little River floodplain, 4 mi W of Midway, rotten log, 9 Mar 1967, *Breil 1580* (NY). **Jefferson Co.:** Monticello, Feb 1890, *Lighthipe s.n.* (NY). **Lake Co.:** Eustis, 17 Jan 1891, *Underwood 1480 (33)* (NY). **Leon Co.:** Game's woods, 9 Aug 1944, *Breen 2318* (NY). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, cypress dome, 1990–1992, *Amoroso 552, 556* (FLAS, Amoroso & Judd 1995). **Polk Co.:** Redfearn (1952). **Marion Co.:** Silver Green Springs, Ocala National Forest, *Schuster 42198a* (Schuster 1974). **Seminole Co.:** Sanford, Mar 1914, *Rapp s.n.* (NY); McFarlin (1940); Redfearn (1952). **Volusia Co.:** Enterprise, 1888, *Donnell Smith s.n.* (NY). **Without Co.:** Haynes (1915); Frye & Clark (1945).

Cephalozia connivens (Dicks.) Lindb.

Baker Co.: Breil (1970). **Bay Co.:** Breil (1970). **Columbia Co.:** Breil (1970). **Gadsden Co.:** Aspalaga, on rotten wood, 29 Jan 1944, *Breen 2203* (NY); Breil (1970). **Highlands Co.:** Highlands Hammock State Park, 6 mi W of Sebring, over bark of dead pine lying at edge of brook, 28 Dec 1950, *Schuster 20099a* (NY, Schuster 1974); Sebring, 1934, *McFarlin 606* (Kurz & Little 1933, Frye & Clark 1945); McFarlin (1940); Redfearn (1952). **Hillsborough Co.:** N Tampa, Dale Mabry Highway at Busch Blvd., on shaded bank of pond, with *Telaranea nematodes*, 14 Sep 1984, *Lassiter & Lassiter 3028* (FLAS-B061974). **Holmes Co.:** along Holmes Creek, near Bonifay, 8 Nov 1937, *McFarlin 1662* (FLAS-B055802). **Lake Co.:** Eustis, Jan–Apr 1891, *Underwood 1720* (NY); Alexander Springs, Ocala National Forest, *Schuster 33432a* (Schuster 1974); McFarlin (1940); Redfearn (1952). **Leon Co.:** Caldwell's Woods, off Old Bainbridge Road, moist soil, 1 Oct 1951, *Breen 2551* (NY); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in marsh, 1990–1992, *Amoroso 556, 560, 572, 573, 935, 938* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Gum Swamp, Ocklockonee River, 16 Oct 1943, [*Breen*] *2175* (NY); Breil (1970). **Marion Co.:** Ocala Scrub, Rolling Hills Road, 17 Apr 1948, *Breen 2437* (NY); Juniper Springs, Ocala National Forest, *Schuster 33466* (Schuster 1974). **Martin Co.:** coastal hammock, 29 May 1980, *Sauleda et al. 3587* (USF). **Miami-Dade Co.:** Mahogany Hammock, Everglades National Park, *Schuster 38356* (Schuster 1974). **Okaloosa Co.:** wayside park at Cox Bridge on Florida 85, over Shoal River ca. 4.5 mi S of Crestview, among surface roots at edge of marshy area along stream with *Isopterygium tenerum, Atrichum angustatum, Thuidium allenii* and *Ditrichum pallidum*, 14 Sep 1980, *Rapp s.n.* (FLAS-B037482).). **Polk Co.:** Avon Park Air Force Bombing Range near Sebring, small mixed bayhead in peaty floodplain marsh, on hummocks and bases of trees, 11 May 1999, *Lassiter & Lassiter s.n.* (NY). **Seminole Co.:** Sanford, Feb 1913, *Rapp 32* (NY); Sanford, on swampy ground, *Rapp 32* (Haynes 1915); McFarlin (1940); Redfearn (1952). **Taylor Co.:** Breil (1970). **Volusia Co.:** Port Orange, 23 Feb 1895, *Straub 207* (NY); Port Orange, 1899, *Howe s.n.* (Schuster 1974); McFarlin (1940); Redfearn (1952).

Cephalozia connivens var. **bifida** R.M. Schust., Hep. Anthoc. N. Amer. 3:809. 1974. TYPE: FLORIDA. HIGHLANDS CO.: Highlands Hammock State Park, 6 mi W of Sebring, edge of brook, on bark of fallen pine tree, *Schuster 20099a*.

Cephalozia lunulifolia (Dumort.) Dumort

Cephalozia media Lindb., *fide* Schuster (1974).

Cephalozia serriflora Lindb., *fide* Schuster (1974).

Baker Co.: Breil (1970). **Bay Co.:** Breil (1970). **Clay Co.:** ca. 0.5 mi E of Rte. 21 on small sand road, along S fork of Black Creek, T6S, R24E, Sec. 27, moist forest, on exposed roots in mucky area, full shade, 30 Sep 1983, *Griffin 332* (FLAS-B046272). **Columbia Co.:** O'Leno State Park on floodplain of Santa Fe River, in dark green patches on peat over root, 28 Jul 1967, *Breil 1868* (NY); Breil (1970). **Franklin Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Highlands Co.:** Sebring, 1934, *McFarlin 1146* (Kurz & Little 1933, Frye & Clark 1945); McFarlin (1940); Redfearn (1952). **Hillsborough Co.:** USF Golf Couse, on damp tree trunk in swamp, 14 Jan 1970, *Lee s.n.* (USF). **Jefferson Co.:** Breil (1970). **Lake Co.:** Alexander Springs along the Timucuan Trail, hardwood swamp, on wet soil among palm roots, 22 Sep 1991, *Fisher FL099121* (FLAS-B057184). **Leon Co.:** Cascades, 10 mi W of Tallahassee, S of State Road 20, 6 Nov 1967, *Breen 221A* (NY); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, cypress dome, 1990–1992, *Amoroso 554* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Breil (1970). **Polk Co.:** McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on sandy banks, Jan 1911, *Rapp 34* (NY, Haynes 1915); Sanford, on rotten logs in hammock, *Rapp 35* (Haynes 1915); McFarlin (1940); Redfearn (1952). **Union Co.:** Breil (1970). **Volusia Co.:** Port Orange, 23 Feb 1895, *Straub 208* (NY). **Walton Co.:** DeFuniak Springs, ca. 0.25 mi N of Magnolia Cemetery, marshy shore of lake with *Sematophyllum adnatum*, Oct 1980, *Rapp s.n.* (FLAS-B037483). **Wakulla Co.:** St. Marks Wildlife Refuge, 1 May 1948, *Linthicum 2455* (NY). **Washington Co.:** Breil (1970).

Odontoschisma denudatum (Nees) Dumort.

Columbia Co.: Breil (1970). **Gadsden Co.:** Glen Julia, *Schornherst 554* (Schuster 1974). **Leon Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Without Co.:** Kurz & Little (1933); Frye & Clark (1945).

Odontoschisma prostratum (Sw.) Trevis.

Citrus Co.: 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, on boulder in low hammock, 19 Jul 1981, Lassiter *& Lassiter 625* (USF). **Escambia Co.:** Pensacola, 1935, *Frye s.n.* (Frye & Clark 1945). **Hernando Co.:** SR 491, 5 mi NW of Brooksville, V. Lones-J.B. Brooks Preserve, 21 Feb 1981, Lassiter *& Lassiter 511* (USF). **Highlands Co.:** Highlands Hammock State Park, *Schuster s.n.* (Schuster 1974); Mohr (1901); McFarlin (1940); Frye & Clark (1945); Redfearn (1952). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, with moss at base of cypress on river bank, 3 Mar 1980, Lassiter*& Lassiter 311* (USF); Hillsborough River State Park, *Schuster s.n.* (Schuster 1974). **Lake Co.:** Alexander Springs, Ocala National Forest, *Schuster s.n.* (Schuster 1974); McFarlin (1940); Redfearn (1952). **Lee Co.:** Redfearn (1952). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in marshes, swamps and cypress domes 1990–1992, *Amoroso 528, 543, 552, 553, 572* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Bristol, 1937, *McFarlin 1493* (Frye & Clark 1945); Torreya State Park & Alum Bluff, Apalachicola River, *Schuster s.n.* (Schuster 1974). **Manatee Co.:** McFarlin (1940); Redfearn (1952). **Marion Co.:** Juniper Springs, Ocala National Forest, *Schuster s.n.* (Schuster 1974). **Martin Co.:** in coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3573* (USF). **Miami-Dade Co.:** hammock SW of tip of Long Key pineland, "Mahogany Hammock," Everglades National Park, *Schuster s.n.* (Schuster 1974). **Orange Co.:** Rock Springs Run, 7 mi N of Apopka, scattered in *Leucobryum albidum* mats on mound of soil at water's edge, 23 May 1982, Lassiter *et al. 630* (USF). **Pasco Co.:** McFarlin (1940); Redfearn (1952). **Pinellas Co.:** Brooker Creek Park, base of *Quercus* in low hammock, 18 Sep 1983, Lassiter *et al. 723* (USF). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, growing over roots and on sandy banks, 1916, *Rapp 36* (Haynes 1915, Frye & Clark 1945); McFarlin (1940); Redfearn (1952). **Volusia Co.:** McFarlin (1940); Redfearn (1952). **Walton Co.:** Shoal River, 5 mi N of Mossy Head, *Schornherst s.n.* (Schuster 1974).

Common on the coastal plain of Florida (Breil 1970).

CEPHALOZIELLACEAE

Cephaloziella hyalina Douin, Mém. Soc. Bot. France 29:77. 1920. TYPE: FLORIDA. SEMINOLE CO.: Sanford, Dec 1915, *Rapp 78* [cited as "Rapp 781" by Schuster (1980)]. (LECTOTYPE: NY). Lectotypified by Schuster (Hep. Anthoc. N. Amer. 4:52. 1980).

Columbia Co.: O'Leno State Park, River Sink trail, on sandy soil in oak-pine scrub, full sun to moderate illumination, 31 Oct 1992, *Whitehill WCW-COL0049* (FLAS-B058597); O'Leno State Park, along slough of Santa Fe River, 7 Nov 1981, *Bryology Class of 1981* (FLAS-B042252); Breil (1970). **Holmes Co.:** Breil (1970). **Lake Co.:** Ocala National Forest, along Forest Service Rd. 538-A from Forest Service Road 538 to Alexander Springs Creek, ca. 2 mi SE of Alexander Springs, pine forest with live oak hammock, 6 Dec 1988, *Buck 16738* (NY). **Leon Co.:** Breil (1970). **Liberty Co.:** Torreya State Park, on bluff along Apalachicola River, *Schuster 44040d* (Schuster 1980). **Pasco Co.:** SR. 54, 1.5 mi W of I-75, near Quail Hollow, on partly shaded cypress log in cut-over swamp, log burned in past, 27 Jan 1981, Lassiter *& Lassiter 504* (USF). **Seminole Co.:** s.l., s.c. (Redfearn 1952); Sanford, on sandy bank, Dec 1915, *Rapp s.n.* (NY); *s.d.*, *Rapp 78* (Frye & Clark 1937); Sanford, 1917, *Rapp 60* (Verdoorn 1931, Frye & Clark 1945); Sanford, footpath, 23 Jan 1917, *Rapp s.n.* (FLAS-B7365). **Without Co.:** *s.l.*, *s.c.* (Brown 19[illegible]; Frye & Clark 1937).

Cephaloziella hyalina var. **rappii** (Douin) R.M. Schust.

Cephaloziella rappii Douin, Mém. Soc. Bot. France 29:77. 1920. TYPE: FLORIDA. SEMINOLE CO.: Sanford, on stumps and sandy banks, Apr 1912, *Rapp 47* (HOLOTYPE: NY).

Clay Co.: W of Green Cove Springs, bank of Black Creek, on sandy soil, 23 Apr 1972, *Griffin s.n.* (FLAS). **Seminole Co.:** Oviedo Road, on clay

bank, Mar 1928, *Rapp s.n.* (FLAS). Sanford, on stumps and sandy banks, Apr 1912, *Rapp 47* (Schuster 1980); Sanford, 1917, *Rapp 60* (Frye & Clark 1945, Schuster 1980, Verdoorn 1931).

Cylindrocolea obliqua (Douin) R.M. Schust., Nova Hedwigia 22:167. 1972. TYPE: FLORIDA. SEMINOLE CO.: *Rapp s.n.*

Cephaloziella obliqua Douin

Bay Co.: Breil (1970). **Clay Co.:** W of Green Cove Springs, bank of Black Creek, plants of moist, sandy bank, 23 Apr 1972, *Griffin s.n.* (FLAS-B016049). **Columbia Co.:** O'Leno State Park on floodplain of Santa Fe River, in dull, black-green mats over peat at base of dead tree, 28 Jul 1967, *Breil 1867* (NY, Breil 1970); O'Leno State Park, along Santa Fe Road, N of High Springs, *Schuster 37278* (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44322, 44323* (Schuster 1980). **Liberty Co.:** along Ochlockonee River at high floodline, 21.5 mi E of Wilma off Forest Highway 13, shaded soil at base of trees (swamp hardwoods & cypress), 28 Dec 1990, *Davison 1499* (NY). **Seminole Co.:** Sanford, side of ditches, Mar 1917, *Rapp 79* (NY); (Redfearn 1952); Sanford 1920, *Rapp 79*; Apr. 13, 1921, *Rapp s.n.* (Frye & Clark 1937, associated with the name *rappifolia*); Sanford, on sandy creek, 9 Feb 1917, *Rapp s.n.* (FLAS-B020565). **Walton Co.:** Floodplain banks of the Shoa River 2 mi N of Mossy Head on S-285, on soil, 22 Sep 1967, *Breil 2028* (NY, Breil 1970).

According to Schuster (1980) this species is confined to an "Oligocene I" region. He noted that "The reproductive structures and sporophyte of *C. obliqua* were probably wanting in the type material, for they were not described. They were also wanting in Rapp's No. 79, probable isotype." Gradstein and Costa (2003) placed this species under the synonymy of *Cylindrocolea planifolia* (Douin) R.M. Schust. without further explanation. In their Brazilian treatment they did not deal with North American material.

Cylindrocolea rhizantha (Mont.) R.M. Schust.

Cephaloziella floridae Douin, Rev. Gén. Bot. 28:312. 1916. TYPE: FLORIDA. SEMINOLE CO.: *Rapp s.n.*

Cephaloziella rhizantha (Mont.) Steph.

Highlands Co.: Highlands Hammock State Park, W of Sebring, *Schuster 33724* (Schuster 1956); on bark of old *Quercus virginiana*, 25 Dec 1952, *Schuster 26015* (NY, Schuster 1980); Redfearn (1952). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 33910, 33923, 33924* (Schuster 1956, 1980); Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on open soil bordering coastal hammock, 13 Aug 1982, *Lassiter & Lassiter 808* (USF); Cockroach Bay Environmental Center, in mangrove, on rotten and sandy soil (Te Strake et al. 1986). **Lafayette Co.:** Breil (1970). **Lake Co.:** Lake Griffin State Park, shrub thicket at pond margin, base of tree trunk, 27 Oct 1968, *Griffin s.n.* (FLAS-B013405). **Leon Co.:** Breil (1970). **Miami-Dade Co.:** Redfearn (1952). **Monroe Co.:** Key Largo, *McFarlin s.n.* (Douin 1920, Frye & Clark 1937, Redfearn 1952, Schuster 1980). **Seminole Co.:** Sanford, on log in swamp, Jun 1912, *Rapp 57* (NY); Sanford, 1920, *Rapp 56* (Frye & Clark 1945); Redfearn (1952).

CHONECOLEACEAE

Chonecolea doellingeri (Nees) Grolle

Clasmatocolea doellingeri (Nees) Steph.

Citrus Co.: near SR 44, ca. 3 mi SW of Crystal River, large coastal hammock, on burned *Sabal palmetto*, with trace of *Octoblepharum albidum*, *Lassiter & Lassiter 3069* (FLAS-B61978). **Flager Co.:** 4 mi S of Marineland, *Schuster 32009a* (Schuster 1980). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on *Sabal palmetto* in coastal hammock, bordering mixed mangrove strand, 13 Aug 1982, *Lassiter & Lassiter 815* (USF); Brandon, E of Tampa, Old Moseley homestead, remnant of mossy hammock, associated with *Cololejeunea minuta* ssp. *myriocarpa*, *Lejeunea cardotii*, *Octoblepharum albidum*, *Syrrhopodon* sp., and *Isopterygium* sp., 15 Dec 1988, *Lassiter & Lassiter 2249, 2250* (FLAS); Cockroach Bay Environmental Center, in mangrove, on *Sabal palmetto*, *Quercus virginiana* and rotten wood (Te Strake et al. 1986); Hillsborough River State Park, hammock forest along Hillsborough River, *Schuster 33934, 33932* (Schuster 1980). **Jefferson Co.:** along US 98 E of the Aucilla River (Breil 1970); W of Enconfina, Aucilla River, *Schuster & Breen s.n.* (Schuster 1980). **Levy Co.:** Waccassasa Bay & Cedar Key Scrub State Preserves, Summer Quadrangle, sect. 10, in coastal hammock, 15–20 ft., 14 Oct 1981, *Griffin 2197, 2247* (FLAS-B061103, B060952); Waccassasa Bay & Cedar Key Scrub St Preserves, in coastal hammock, Sumner Quadrangle, sect 10, 14 Oct 1981). **Marion Co.:** Juniper Springs Recreation Area, 120 ft., on *Sabal* trunk, 31 Mar 1969, *Griffin s.n.* (FLAS-B61103), Juniper Springs, Ocala National Forest, *Schuster s.n.* (Schuster 1980); Alexander Springs, S of Astor Park, Ocala National Forest, *Schuster s.n.* (Schuster 1980); Juniper Springs Recreation Area, 120 ft., on sabal trunk, 31 Mar 1969, *Griffin s.n.* (FLAS-B013447). **Hillsborough Co.:** Cockroach Bay Environmental Center, in mangrove, on *S. palmetto*, *Quercus virginiana* and rotten wood (TeStrake *et al.* 1986); Brandon, E of Tampa, Old Moseley homestead, remnant of messy hammock, associated with *Cololejeunea minuta* ssp. *Myriocarpa*, *Lejeunea cardoti*, *Octoblepharum albidum*, *Syrrhopodon* sp. and *Isopterygium* sp., 15 Dec 1988, *Lassiter & Lassiter 2249, 2250* (FLAS-B054759, B054754). **Polk Co.:** McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on palmetto roots and logs, *Rapp 33* (Haynes 1915); 1934, *Rapp s.n.* (Frye & Clark 1943); Redfearn (1952). **Sarasota Co.:** Myakka State Park, S shore of upper Lake Myakka, *Quercus virginiana*-*Sabal palmetto* forest, on trunk of *Q. virginiana*, 28–29 Nov 1975, *Griffin 10122a* (FLAS-B 023664). **Seminole Co.:** Sanford, *Rapp s.n.* (Schuster 1980). **Taylor Co.:** S of Hampton Springs, s.c., s.n. (Breil 1970). **Volusia Co.:** Hontoon Island State Park in St. Johns River near DeLand, low hydric hammock, on trunk of cabbage palm (*Sabal palmetto*), 12 May 1987, *Griffin et al. 464* (FLAS-B51698); Tomoka State Park near Daytona Beach, in open coastal hammock

fringe, on *Sabal palmetto*, with *Syrrhopodon* sp., 21 Oct 1988, *Lassiter & Lassiter 2248* (FLAS-B054753); S of Lake George, NE of Astor, *Schuster s.n.* (Schuster 1980); Hontoon Island State Park, W of DeLand, *Schuster s.n.* (Schuster 1980).

Chonecolea doellingeri occurs at low elevations as a neotropical disjunct in Florida (Gradstein et al. 2001). Although Schuster (1980) described this species as having rounded leaf lobes, some collections (e.g., *Lassiter & Lassiter 3069, Griffin 10122a*) may show acute leaf lobes.

CONOCEPHALACEAE

Conocephalum salebrosum Szweyk. et al.

Alachua Co.: Devil's Millhopper, moist limestone, 14 Apr 1972, *Buck s.n.* (NY). **Gadsden Co.:** as *Conocephalum conicum* (L.) Underw., Breil (1970). **Jackson Co.:** Marianna Caverns State Park on S-167, limestone area on floodplain of Chipola River, 26 Apr 1967, *Breil 1667* (NY); Marianna, along Chipola River, on lime cliff, as *Conocephalum conicum, Kurz s.n.* (Kurz & Little 1933, Frye & Clark 1937); Florida Caverns State Park, near Chipola River, as *Conocephalum conicum,Schuster 44132* (Schuster 1992b); Breil (1970). **Pinellas Co.:** Oldsmar Flea Market, Race Track Road, near Oldsmar, common on Canadian peat soil in cultivated plants, 16 Jan 1982, as *Conocephalum conicum*, Lassiter & *Lassiter 574, 815* (USF). **Taylor Co.:** 0.5 mi NE of US 19 on FL 51 at Steinhatchee River, on limestone outcropping, 1 Apr 1950, *Nielsen 2535* (NY).

We accept the conclusions of Szweykowski et al. (2005) in which true *Conocephalum conicum* (L.) Dumort. is restricted to Europe and *C. salebrosum* is Holarctic in distribution and is the only known species of the genus in North America.

DUMORTIERACEAE

Dumortiera hirsuta (Sw.) Nees

Alachua Co.: Devil's Millhopper, 6 mi NW of Gainesville, *Little s.n.* (Kurz & Little 1933, Schuster 1992b); along run S of Athletic Field, Gainesville, *Little s.n.* (Kurz & Little 1933); Gainesville (Schuster 1992b). **Bay Co.:** Breil (1970). **Citrus Co.:** Pineola Grottoes near Istachatta, T21S, R20E, Sec. 1, large mats on shaded, large limestone boulders near water, 2 Dec 1979, Lassiter & *Lassiter 278* (USF); Redfearn (1952). **Gadsden Co.:** Mountain Laurel Creek, *Schornherst 2164* (Schuster 1992b); Apalachicola River, *Correll 8576* (Schuster 1992b); Breil (1970). **Hernando Co.:** Istachatta, covering huge limestone rock in front of limestone caves in shady hardwood type area, on old Brown Farm via US 41, 48, S39, then turn W on 4th Street, 11 May 1974, *Arcuri 26* (USF). **Jackson Co.:** Breil (1970). **Leon Co.:** Tallahassee, 4 mi along road to Quincy, *Kurz s.n.* (Kurz & Little 1933). **Liberty Co.:** Torreya State Park, *Schuster s.n.* (Schuster 1992b); Torreya State Park, trail near campground, on soil in spray of waterfall of small stream, shaded, 29 Oct 1976, *Whitten 47* (FLAS-B60691). **Marion Co.:** Indian Springs near Ocala, *Underwood & Cook, Ameri. Hep. No. 20.* (Schuster 1992b). **Washington Co.:** Breil (1970). **Without Co.:** Miernen, 1917, *Noble s.n.* (Frye & Clark 1937); Apalachicola River, *Correll 8576* (Schuster 1992b); Apalachicola River, *Schuster s.n.* (Schuster 1992b).

Dumortiera hirsuta subsp. **nepalensis** (Taylor) R.M. Schust.

Alachua Co.: along run bordering Gainesville in the north, *Little s.n.* (Kurz & Little 1933); Gainesville, 1909, *Harper s.n.* (Kurz & Little 1933, Schuster 1992b); Gainesville, 1915, *Nelson s.n.* (Kurz & Little 1933, Schuster 1992b); Devil's Millhoper, *Schuster s.n.* (Schuster 1992); Devil's Millhopper, Gainesville, moist bank near bottom of sinkhole, 13 Oct 1991, *Whitehill WCW-ALC0024* (FLAS-B57466); Devil's Millhopper, 6 mi). N of Gainesville, 3 Dec 1967, *Griffin s.n.* (FLAS-B13480).**Citrus Co.:** Pineola, on rocks in fern grotto, 7 Jan 1936, *McFarlin s.n.* (FLAS-B21040); Pineola, *Small s.n.* (Schuster 1992b); *Schuster s.n.* (Schuster 1992b); Redfearn (1952). **Columbia Co.:** Ichetucknee Springs State Park, ca. 1.75 mi NE of the S park entrance along Mill Pond Spring, wet soil at site of old grist mill, 20 Oct 1991, *Fisher FI.109104*, (FLAS-B057195).). **Sumter Co.:** Cat Hammock, woodlands, limestone, 15 Dec 1967, *Griffin s.n.* (FLAS). **Without Co.:** Evans (1917); Frye & Clark (1937).

Schuster (1954, 1992b) stated that in the United States, this subspecies is restricted to two disjunct areas: Escarpments of the Appalachian Mountains and an Oligocene Island Region in Central Florida.

FOSSOMBRONIACEAE

Fossombronia foveolata Lindb.

Fossombronia salina Lindb., *fide* Stotler & Crandall-Stotler (2005).

Collier Co.: Collier-Seminole State Park, Dec 1955, *Bryan s.n.* (Schuster 1992a). **Liberty Co.:** Apalachicola River floodplain (Breil 1970).

Fossombronia lamellata Steph.

Lake Co.: McFarlin (1940); Redfearn (1952); Schuster (1992). **Seminole Co.:** Sanford, 1924, *Rapp s.n.* (Frye & Clark 1937); Sanford, *Rapp 1915, 1916, 1917, 1920* (Schuster 1992a); Redfearn (1952). **Without Co.:** Evans (1917); Frye & Clark (1937).

Fossombronia porphyrorhiza (Nees) Prosk.

Fossombronia brasiliensis Steph.

Fossombronia angulosa (Dicks.) Raddi, fide Schuster (1992a).

Calhoun Co.: Breil (1970). **Highlands Co.:** Highlands Hammock State Park, *Schuster 44324, 44325* (Schuster 1992a). **Hillsborough Co.:** Horizon Park, Himes and Hillsborough Aves., on moist soil, 2 Mar 1970, Griepenburg 32 (USF). **Jefferson Co.:** 4 mi SW of Flint Rock, *Kurz s.n.* (Kurz & Little 1933). **Lake Co.:** Eustis, *Underwood & Cook s.n.* (*Hep. Amer. no. 118*) (Schuster 1992a). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in marsh, 1990–1992, *Amoroso 569* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Torreya State Park, Apalachicola River slope, *Schuster 44041, 44042c* (Schuster 1992a). **Okeechobee Co.:** between Okeechobee and Arcadia, *Grout s.n.* (Schuster 1992a). **Seminole Co.:** Sanford, on sandy banks, *Rapp* 2 (Haynes 1915); Sanford, *Rapp s.n.* (Schuster 1992a); Redfearn (1952). **Wakulla Co.:** Breil (1970). **Without Co.:** Haynes (1915); Frye & Clark (1937).

Fossombronia wondraczekii (Corda) Dumort.

Gadsden Co.: Aspalaga Bluff along Apalachicola River (Breil 1970). **Polk Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Without Co.:** Haynes (1915); Frye & Clark (1937).

FRULLANIACEAE

Frullania brittoniae A. Evans

Alachua Co.: Devil's Millhopper, branches of canopy of *Carpinus caroliniana*, 5 May 1972, *Buck s.n.* (NY). **Collier Co.:** 2 mi SW of Belle Meade, Rookery Bay Estuarine Preserve, T51S, R26E, Sec. 17, on *Laguncularia racemosa* in mangrove strand by boat ramp, 24 Oct 1980, *Merner 488* (USF). **Hillsborough Co.:** Tampa Bay, Big Cockroach Mound, S of Cockroach Bay Road, in fissures at sheltered base of large *Bursera simaruba*, 23 Jul 1983, Lassiter *et al. 819* (USF); Hillsborough River State Park, *Schuster 33316* (Schuster 1992a). **Liberty Co.:** Torreya State Park, on *Platanus*, *Redfearn 19555* (Schuster 1992a). **Marion Co.:** Juniper Creek, 2–4 mi below Juniper Springs, Ocala National Forest, *Schuster 33395e, 33397b* (Schuster 1992a). **Polk Co.:** Redfearn (1952); Schuster (1992a). **Seminole Co.:** Sanford, on *Magnolia glauca* [*M. virginiana*], Oct 1914, *Rapp 77* (NY, Haynes 1915, Frye & Clark 1947, Schuster 1992a). **Sumter Co.:** I-75 northbound, rest area just N of Withlacoochee River, on fallen twig under *Quercus* sp., 11 Jun 1980, Lassiter *& Lassiter 430* (USF). **Washington Co.:** Breil (1970); Schuster (1992a).

Frullania caulisequa (Nees) Nees

Frullania obcordata (Lehm. & Lindenb.) Lehm. & Lindenb., *fide* Yuzawa (1988).

Alachua Co.: Gainesville, on trees in the streets, *Little s.n.* (Kurz & Little 1933). **Bay Co.:** Breil (1970). **Clay Co.:** Cove Spring, near St. Johns River, *Blomquist 9045* (Schuster 1992a). **Collier Co.:** Collier-Seminole State Park, *Schuster s.n.* (Schuster 1992a); Loop Road, Rte. 94, 3 mi S of Monroe Station, Everglades, *Schuster 37151c* (Schuster 1992a). **Columbia Co.:** Lake City, 16 Dec 1894, *Straub 146* (NY). **Gadsden Co.:** Breil (1970). **Hernando Co.:** SE of Brooksville, *Schuster 22735d* (Schuster 1992a). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 22868b, 22881a, 33909c* (Schuster 1992a). **Holmes Co.:** Breil (1970). **Jefferson Co.:** Monticello, on young trees, Mar 1890, *Lighthipe 37* (NY); 1 mi W of Aucilla River, Rte. 98, *Schuster 44202a* (Schuster 1992a); Breil (1970). **Lake Co.:** Eustis, Jan–Apr 1891, *Underwood 1611* (NY); Alexander Springs, Ocala National Forest, *Schuster 33425d, 33385d* (Schuster 1992a). **Leon Co.:** Game's woods, 9 Aug 1944, *Breen 2323* (NY); Tallahassee, 3 mi along road to Quincy, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 539, 562, 1108* (FLAS, Amoroso & Judd 1995); Manatee Springs State Park near Chiefland, *Schuster 44225a* (Schuster 1992a). **Liberty Co.:** Johnson's Juniper Swamp, log off ground, on dry rotten bark, large cypress (*T. ascendens*), 12 Mar 1952, *Wagner & Kurz s.n.* (NY); Breil (1970). **Manatee Co.:** 15 mi N of Manatee, *Blomquist 8925b* (Schuster 1992a). **Marion Co.:** Ocala National Forest, 3.4 mi N of the intersection of Rte. 19 & Rte. 40, cabbage palm to scrub area, growing on *Quercus myrtifolia*, 26 Jan 1974, *Frantz 92* (NY); Juniper Creek, Ocala National Forest, 3–4 mi below Springs, *Schuster 33395g, 33446, 33462a* (Schuster 1992a); Juniper Springs, Ocala National Forest, *Schuster 22474, 31911b, 31912a* (Schuster 1992a). **Miami-Dade Co.:** Long Key pineland, Everglade Keys, *Schuster 22145d* (Schuster 1992a); Everglades National Park, Paradise Key, *Schuster 20184, 20169* (Schuster 1992a); Mahogany Hammock, near SW tip of Long Pine Key, *Schuster 37328d* (Schuster 1992a); Redlands Hammock (now destroyed), near Kings Hwy. and Richard Road, NW of Homestead, *Schuster 42122b* (Schuster 1992a). **Nassau Co.:** Dillard, *Blomquist 9060* (Schuster 1992a). **Orange Co.:** Wekiwa Springs, on tree trunk, 29 Apr 1956, *Schallert 1006* (NY). **Putnam Co.:** N of Orange Springs, Rte 315, *Schuster 42213, 42213a* (Schuster 1992a). **Seminole Co.:** near Sanford Range, Sanford, May 1931, *Rapp s.n.* (NY); Sanford, on tree trunks and branches, *Rapp 43* (Haynes 1915, Frye & Clark 1947); Sanford, 1918, *Rapp s.n.* (Schuster 1992a). **Walton Co.:** floodplain of Shoal River 2 mi N of Mossy Head on S-285, on *Vaccinium*, 22 Dec 1967, *Breil 2027* (NY); Breil (1970).

Frullania cobrensis Gottsche ex Steph.

Hernando Co.: N of Brooksville, 1949, *Wagner & Redfearn s.n.* (Schuster 1992a). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44281a* (Schuster 1992a). **Lake Co.:** Alexander Springs, near Astor Park, Ocala National Forest, *Schuster 33316c, 33385d* (Schuster 1992a). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in cypress dome, 1990–1992, *Amoroso 576.5, 934, [illegible].5* (FLAS, Amoroso & Judd 1995); Manatee Springs State Park, near Suwannee River, near Chiefland, *Schuster 44248a* (Schuster 1992a). **Miami-Dade Co.:** Deer Hammock, Long Pine Key, Everglades National Park, *Schuster 44451b* (Schuster 1992a). **Polk Co.:** near Medulla,

1949, *Redfearn s.n.* (Schuster 1992a). **Seminole Co.:** Sanford, on maple, *Rapp 57* (Evans 1913, Haynes 1915, Frye & Clark 1947, Schuster 1992a).

Frullania compacta Gottsche ex Steph.

Collier Co.: Collier-Seminole State Park, *Schuster 26009* (Schuster 1992a); Fakahatchee Cypress Swamp, NW of Copeland, *Schuster 82-3131* (Schuster 1992a).

Frullania donnellii Austin, Bull. Torrey Bot. Club 52:301. 1879. TYPE: FLORIDA: East Florida, Mar 1877, *Donnell Smith s.n.*

Collier Co.: Collier-Seminole State Park, oak bark, 7 Mar 1957, *Redfearn 3037* (NY); Collier-Seminole State Park, on twigs of *Zanthoxylum fagara*, *Schuster 26158a* (Schuster 1992a). **Hernando Co.:** Brooksville, US 98, NW of town, on boulder in border of mesic woods, 20 May 1984, *Lassiter & Lassiter 2147* (USF). **Jefferson Co.:** Monticello, on bark of young trees, Mar 1890, *Lighthipe 98* (NY); Monticello, *Lighthipe s.n.* (Schuster 1992a). **Lake Co.:** Eustis, 17 Jan 1891, *Underwood 1461(29)* (NY); Eustis, *Underwood s.n.* (Schuster 1992a); Alexander Springs, Ocala National Forest, *Schuster 33425d, 33429b, 33436, 33385b, 33430b* (Schuster 1992a). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub, 1990–1992, *Amoroso 805* (FLAS, Amoroso & Judd 1995); N of Gulf Hammock, hammock forest, *Schuster F-131* (Schuster 1992a). **Liberty Co.:** Small ravine cut in Alum Bluff, Apalachicola R., *Schuster 33535* (Schuster 1992a); Breil (1970). **Marion Co.:** along Juniper Creek, 2–3 and 3–4 mi below Juniper Springs, Ocala National Forest, *Schuster 33451, 33446a* (Schuster 1992a); Juniper Springs, dense hammock forest, *Schuster 22093a* (Schuster 1992a); Juniper Springs, scrubby, open *Quercus chapmanii-Q. geminata* scrub, *Schuster 31939a, 31938c* (Schuster 1992a); 10 mi W of Juniper Springs, scrub forest, *Schuster 22460* (Schuster 1992a). **Miami-Dade Co.:** Everglades National Park, Deer Hammock, Long Pine Key, at base of *Gymnanthes lucida*, burned, open hammock edge, *Schuster 44451a, 44452c, 44455, 44456a* (Schuster 1992a); Mahogany Hammock, SW of tip of Long Pine Key, *Schuster 37328c, 37310a, 37313b, 37341b, 37331c* (Schuster 1992a). **Putnam Co.:** N of Orange Springs, Rte 315, *Schuster 42213a* (Schuster 1992a). **Seminole Co.:** Sanford, on various barks, *Rapp 75* (NY, Evans 1897, Haynes 1915, Frye & Clark 1947).

Frullania eboracensis subsp. **virginica** (Gottsche) R.M. Schust.

Columbia Co.: Breil (1970). **Gadsden Co.:** Flat Creek, 4 mi S of River Junction, *Kurz s.n.* (Kurz & Little 1933). **Highlands Co.:** Sebring, 1934, *McFarlin 1122, 1123, 1159, 1166* (Frye & Clark 1947). **Hillsborough Co.:** Tampa, Drew Park section, on large *Quercus virginiana* across from Hillsborough Community College, 7 Apr 1985, Lassiter & *Lassiter 2116* (USF). **Jefferson Co.:** Monticello, Mar 1890, *Lighthipe 37* (NY); Breil (1970). **Lake Co.:** Ocala National Forest, Alexander Spring Creek at end of Forest Service Rd. 552, swamp forest with *Taxodium*, *Sabal*, and hardwoods, 6 Dec 1988, *Buck 16778* (NY). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 802, 934* (FLAS, Amoroso & Judd 1995); near Cedar Key, 0.5 mi N of SR24 on SR 347, on *Quercus* sp. in "scrub jay" type of scrub, 29 Mar 1980, *Merner 362* (USF). **Liberty Co.:** Ochlockonee River, gum swamp, 16 Oct 1943, *[Breen] 2177* (NY); Torreya State Park, *RMS* (Schuster 1992a). **Martin Co.:** coastal hammock, on rotting wood with moss, 29 May 1980, *Sauleda et al. 3575* (USF). **Seminole Co.:** Altamonte Springs, on tree trunk, 8 Dec 1955, *Schallert 891* (NY). **Volusia Co.:** DeLand, near Stetson University, Michigan Ave, 24 Apr 1982, Lassiter & *Lassiter 616* (USF).

We follow Schuster's treatment (Schuster 1992a) and consider all prior reports of *Frullania eboracensis* in Florida to be representative of *F. eboracensis* subsp. *virginica*.

Frullania ericoides (Nees) Mont.

Frullania squarrosa (Reinw. Blume & Nees) Nees, *fide* Grolle (1968).

Alachua Co.: Devil's Millhopper, branch in canopy of *Cornus florida*, 5 May 1972, *Buck s.n.* (NY). Devil's Millhopper, 2 mi E of Fort White, 10 Dec 1927, *Evans 208* (NY); Lake Walberg, 6 mi S of Gainesville, *Little s.n.* (Kurz & Little 1933). **Bay Co.:** Breil (1970). **Calhoun Co.:** Breil (1970). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, on *Fraxinus caroliniana* in low hammock, 3 Apr 1980, Lassiter *et al. 399* (USF), on *Liquidambar* in low hammock, 3 Apr 1980, Lassiter *et al. 372, 378* (USF). **Clay Co.:** Green Cove, Mar 1884, *[Rau] 4* (NY). **Collier Co.:** Everglades, 3 mi S of Monroe Station, *Schuster 37146a, 37181, 37182, 37157c, 37151a* (Schuster 1992a); Collier-Seminole State Park, over bark, 19–21 Dec 1950, *Schuster 20424* (NY) and *Schuster 19918, 20311, 44372a* (Schuster 1992a); N of Collier-Seminole State Park, N of Tamiami Canal, *Schuster 44360c, 44382, 44232, 44383* (Schuster 1992a). **Columbia Co.:** Lake City, 20 Dec 1894, *Straub 145* (NY); Fort White, 2 mi E, on road to Lake City, *Kurz s.n.* (Kurz & Little 1933). **Dixie Co.:** Breil (1970). **Escambia Co.:** lower bluff, Escambia River, Gonzalez, 24 Nov 1951, *Breen 2595* (NY). **Highlands Co.:** Parker Island, 5 mi S of Lake Istokpoga, exposed lower trunk of a live oak on edge of hammock, 21 Apr 1951, *Brass 21225* (NY); Highlands Hammock State Park, cypress swamp, *Schuster 44281* (Schuster 1992a); Highlands Hammock State Park, 1934, *McFarlin 1126* (Frye & Clark 1947). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, on *Quercus* sp. in low hammock, 24 Apr 1983, Lassiter & *Lassiter 698* (USF); Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on large *Juniperus silicicola* [*J. virginiana*] in coastal hammock, 30 Aug 1980, Lassiter & *Lassiter 476* (USF); Cockroach Bay Environmental Center, in mangrove, on *Juniperus silicicola* [*J. virginiana*] (Te Strake et al. 1986). **Holmes Co.:** Breil (1970). **Jackson Co.:** Florida Caverns State Park, near Marianna, near Chipola R., *Schuster 44134, 44134a* (Schuster 1992a). **Jefferson Co.:** W of Aucilla River, on Rte 98, *Schuster 44188, 44197, 44198b* (Schuster 1992a); Monticello, 27 Feb 1890, *Lighthipe 2* (NY); Kurz & Little (1933); Breil (1970). **Lake Co.:** Alexander Springs, Ocala National Forest, *Schuster 31385e, 33313a* (Schuster 1992a); Eustis, Jan–Apr 1891, *Underwood 1611a* (NY). **Lee Co.:** Sanibel Island, Point Ybel, T46S, R23E, Sec. 21, on *Ficus* roots in heavily disturbed coastal hammock, 22 Mar 1980, Lassiter & *Lassiter 402* (USF);

Sanibel Island, J. N. Darling National Wildlife Refuge, T46S, R22E, Sec. 7, on *Eugenia axillaris* in tropical hammock, 22 Mar 1980, Lassiter & *Lassiter 355* (USF). **Leon Co.:** Caldwell's Woods, Tallahassee, on bark, 21 Oct 1951, *Breen 2552* (NY); Tallahassee, College Campus, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Levy Co.:** Manatee Springs State Park, near Chiefland, *Schuster 44225d, 44232a, 44242, 44244* (Schuster 1992a); N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 1098* (FLAS, Amoroso & Judd 1995); Manatee Springs, 5 Apr 1953, *Breen 3028A* (NY). **Liberty Co.:** Breil (1970). **Marion Co.:** Silver Glen Springs, Ocala National Forest, *Schuster 42197, 42199* (Schuster 1992a); Ocala, 29 Jan 1891, *Underwood 1799* (NY); Juniper Springs, *Schuster 82-3040* (Schuster 1992a). **Miami-Dade Co.:** Timms Hammock, 18 Mar 1915, *Small & Mosier 5281* (NY). **Monroe Co.:** Cape Sable, *McFarlin s.n.* (Schuster 1992a); Cape Sable (East Cape), sand dunes, 28 Nov 1916, *Small 7820* (NY); Cape Sable, *McFarlin s.n.* (Frye & Clark 1947). **Orange Co.:** Wekiwa Springs, moist, on branches, 8 Aug 1956, *Schallert 1095* (NY). **Palm Beach Co.:** Lake Worth, 1891, *Underwood 2167* (NY). **Pasco Co.:** 1 mi N of Port Richey at Salt Springs, T25S, R16E, Sec. 20, on large *Juniperus silicicola* [*J. virginiana*] by creek, 15 Mar 1981, Lassiter & *Lassiter 553* (USF). **Pinellas Co.:** vacant lot opposite 3413 De Bazan Ave., on palm tree, 18 Jan 1957, *Johnson 19781* (NY). **Polk Co.:** Pursegone Creek, N side of FL 60, 1.5 mi E of Hillsborough Co. line, common on *Carpinus caroliniana* in low hammock, 26 Jan 1980, Lassiter & *Lassiter 297* (USF). **Putnam Co.:** N of Orange Springs, Rte 315, *Schuster 42214* (Schuster 1992a). **Saint Johns Co.:** St. Augustine, 28 Mar 1907, *Britton & Britton 53* (NY). **Sarasota Co.:** Myakka State Park, 31 Jul 1952, *Breen 2823* (NY). **Seminole Co.:** Sanford, on tree trunks, Dec 1913, *Rapp 45* (NY, Haynes 1915); 1923, *Rapp s.n.* (Frye & Clark 1947). **Sumter Co.:** I-75 northbound, rest area, just north of Withlacoochee River, on *Quercus* sp. 11 Jun 1980, Lassiter & *Lassiter 429* (USF). **Suwannee Co.:** Suwannee River State Park on US 90, along river on lime cliffs and in river sloughs, on oak, 25 Sep 1967, *Breil 603* (NY); Breil (1970). **Taylor Co.:** Breil (1970). **Union Co.:** Worthington Springs, 29 Aug 1944, *Fisher 76* (NY). **Volusia Co.:** Enterprise, on cedar, 31 Mar 1887, *Benttenmuller 18a* (NY). **Wakulla Co.:** Breil (1970).

Frullania gibbosa Nees

Collier Co.: Fakahatchee Strand State Preserve, along Janes Memorial Scenic Drive, ca. 2 mi NNW of Ranger Station, *Taxodium*-hardwood swamp, *Buck 54473* (NY). **Miami-Dade Co.:** Timms Hammock near Homestead, 1929, *Taylor 1875* (Frye & Clark 1947); Royal Palm Hammock, 1929, *Taylor 1853* (Frye & Clark 1947); Royal Palm Hammock (Paradise Key), Everglades National Park, *Taylor 1875*; Timms Hammock, near Bauer Drive, N of Homestead, *Taylor 1853* (Schuster 1992a); Redlands Hammock, NW of Homestead, N of Kings Hwy., W of Richard Road, *Schuster 42251, 42260* (Schuster 1992a); Everglades National Park, Long Key pineland, NW of campground, *Schuster 44452* (Schuster 1992a); Osteen Hammock, Long Key Pineland, *Schuster 44452, 44473* (Schuster 1992a).

Frullania inflata Gottsche

Frullania rappii A. Evans, Bryologist 15:22. 1912. Type: FLORIDA. Seminole Co.: Sanford, Jun 1911, *Rapp 18*.

Alachua Co.: Newnan's Lake, 6 mi E of Gainesville, *Little s.n.* (Kurz & Little 1933). **Columbia Co.:** O'Leno State Park in floodplain of Santa Fe River, on *Crataegus*, 28 Jul 1967, *Breil 1855* (NY); Breil (1970). **Gadsden Co.:** floodplain sloughs along Ochlockonee River, on black birch, 29 Dec 1967, *Breil 2348* (NY); Breil (1970). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, on *Ulmus* sp. in low woods bordering slough, 30 Dec 1981, Czyzewski 8 (USF). **Holmes Co.:** Breil (1970). **Jefferson Co.:** Lamont, 7 mi S toward Walker Springs, *Kurz s.n.* (Kurz & Little 1933). **Lake Co.:** Eustis, Jan 1891, *Underwood 621* (NY). **Leon Co.:** Caldwell's Woods, Tallahassee, on *Magnolia grandiflora*, 2 Jan 1952, *Breen 2636* (NY); Breil (1970). **Levy Co.:** Manatee Springs State Park, Suwannee River, near Chiefland, *Schuster 44248 , 44235, 44232f, 44233a, 44233* (Schuster 1992a). **Marion Co.:** Ocala, Jan–Apr 1891, *Underwood 1760* (NY). **Monroe Co.:** Key West, s.d., *Howe s.n.* (NY). **Orange Co.:** Wekiwa Springs, on moist tree branch, 24 Jun 1958, *Schallert 1513* (NY). **Seminole Co.:** Sanford, Aug 1912, *Rapp 18* (NY, Haynes 1915); Sanford, *Rapp 21* (Evans 1912); *Rapp 44* (Haynes 1915, Frye & Clark 1947). **Suwannee Co.:** Breil (1970). **Volusia Co.:** Ormand Beach, 5 mi N at Smoak Ranch, 1 Jan 1958, *Donnell Smith s.n.* (NY).

Frullania inflata var **communis** R.M. Schust.

Highlands Co.: Archbold Biological Station, 10 mi S of Lake Placid, *Schuster 44351c* (Schuster 1992a); Highlands Hammock State Park, *Schuster 44281c* (Schuster 1992a). **Seminole Co.:** Sanford and vicinity, *Rapp s.n.* (Schuster 1992a).

Frullania intumescens (Lehm. & Lindenb.) Lehm. & Lindenb.

Frullania cucullata Lindenb. & Gottsche, *fide* Stotler (1969)

Collier Co.: near Everglades, *Eaton 1905*; (NY, Schuster 1992a). **Lee Co.:** Caloosahatchee River, Mar 1878, *Donnell Smith s.n.* (NY, Schuster 1992a). **Without Co.:** Evans (1914); Frye & Clark (1947).

Frullania kunzei (Lehm. & Lindenb.) Lehm. & Lindenb.

Alachua Co.: University of Florida Campus, in canopy, branch of hardwood, 28 May 1972, *Buck s.n.* (NY); Devil's Millhopper, 6 mi NW of Gainesville, *Little s.n.* (Kurz & Little 1933). **Clay Co.:** Kingsley Lake, *Little s.n.* (Kurz & Little 1933). **Citrus Co.:** 3 mi E of Floral City, T20S, R20E, Sec. 13, on *Acer rubrum* in low hammock, 16 Jan 1980, Lassiter *et al. 300* (USF). **Collier Co.:** Lake Trafford, 1935, *McFarlin & Grout 988* (Frye & Clark 1947). **Columbia Co.:** Lake City, 1 Dec 1894, *Straub 147* (NY); Breil (1970). **Escambia Co.:** Pensacola, 1935, *Frye s.n.* (Frye & Clark 1947). **Franklin Co.:** St. George Island State Park, along hiking trail to Gap Point, dry pine woods with small oak hammocks, 11 Dec 1988, *Buck s.n.* (NY). **Gadsden Co.:** Breil (1970). **Gilchrist Co.:** Breil (1970). **Hamilton Co.:** Breil (1970). **Highlands Co.:** Sebring, 1936, *McFarlin 998* (Frye & Clark 1947). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on *Quercus virginiana* in coastal hammock bordering mixed coastal strand, 12 Aug 1982, Lassiter & *Lassiter 855* (USF); Cockroach Bay Environmental Center, in

mangrove, on *Quercus virginiana* and *Conocarpus erectus* (Te Strake et al. 1986). **Holmes Co.:** Breil (1970). **Lake Co.:** Eustis, 21 Jan 1891, *Underwood 1722* (NY). **Lee Co.:** near Fort Myers, in swamp, on old stump, 23 Feb 1946, *Schallert 659* (NY). **Leon Co.:** Lena Stein ravine, 1 Feb 1927, *Kurz 8* (NY); Tallahassee, 3 mi along road to Quincy, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub and swamp, 1990–1992, *Amoroso 561, 679, 682, 800, 802, 804, 807, 1108* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Breil (1970). **Marion Co.:** Ocala, scrub, 17 Apr 1948, *Breen 2443* (NY). **Orange Co.:** Wekiwa Springs, on tree bark, 29 Apr 1956, *Schallert 1001* (NY). **Palm Beach Co.:** Lake Worth, 1891, *Underwood 1808* (NY). **Putnam Co.:** Ocala National Forest, Old Johnson Field Campground along Oklawaha River, N of Forest Service Rd. 77 just W of US 19, swamp forest, 7 Dec 1988, *Buck s.n.* (NY). **Seminole Co.:** Altamonte Springs, on tree bark, 8 Dec 1955, *Schallert 882* (NY); Sanford, on shrubs, trunks, and branches, *Rapp 42* (Evans 1912, Haynes 1915, Frye & Clark 1947). **Wakulla Co.:** Breil (1970). **Washington Co.:** Rock Hill, pine savanna hill with sandstone outcrops, ca. 9 mi S of Chipley, plants with lichens on sandstone, 12 May 1967, *Breil 1709* (NY); Breil (1970).

Frullania riojaneirensis (Raddi) Spruce

Frullania arietina Taylor, *fide* Schuster (1992a).

Collier Co.: 1934, *Grout & McFarlin 1059* (Frye & Clark 1947); Royal Palm Hammock [Collier-Seminole] State Park, edge of Everglades National Park, on Rte. 205, jungle, over twigs and branches, 26 Dec 1950, *Schuster 20172a* (NY); Turner Island, Chokoloskee Bay, hammocks 4 Apr 1916, *Small 7555* (NY); drained cypress swamp just S of Corkscrew Swamp Sanctuary, 30 Mar 1978, *Redfearn 31615* (NY); Rte. 94 (Loop Road), 2.5–3 mi N of Monroe Co. Line, *Schuster 44594a*, 44595 (Schuster 1992a); Rte. 94, 3 mi S. of Monroe Station, *Schuster 37182, 37158b* (Schuster 1992a); Collier-Seminole State Park, *Schuster 26150a, 26141, 26148a, 26147, 26158* (Schuster 1992a); N of Collier-Seminole State Park, 0.5–1.0 mi N of Tamiami Canal, *Schuster 44377a, 44375a, 44371, 44372* (Schuster 1992a). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 19943* (Schuster 1992a). **Lee Co.:** Caloosahatchee River, *Donnell Smith s.n.* (Schuster 1992a). **Miami-Dade Co.:** Brickell Hammock, 19 Mar 1915, *Small 5273* (NY, Frye & Clark 1947, Schuster 1992a); Homestead, 1929, *Taylor 165* (Frye & Clark 1947); 1937, *Muegel s.n.* (Frye & Clark 1947); Timms Hammock, 1940, *Grout s.n.* (Frye & Clark 1947); Timms Hammock, *Grout s.n., Schuster 22858a* (Schuster 1992a); Costello Hammock, *Schuster 22953* (Schuster 1992a); Homestead, *Taylor 165* (Schuster 1992a); Everglades National Park, Deer Hammock, Long Key pineland, *Schuster 44452a, 44453* (Schuster 1992a); Paradise Key, *Schuster 22915b, 20172a* (Schuster 1992a); 2.5–3.5 mi NW of Paradise Key, E end of Long Key pineland, *Schuster 36819b, 36820, 36824, 36834* (Schuster 1992a); on Loveland Road, 5–6 mi W of Florida City, hammock forest, *Schuster 22651c* (Schuster 1992a); Redlands Hammock, near Kings Hwy. and Richard Road, NW of Homestead, *Schuster 42262, 44396, 42260a, 44399a, 44396a* (Schuster 1992a). **Monroe Co.:** Flamingo–Cape Sable, hammocks, 26 Nov 1916, *Small 7813* (NY).

Frullania sabaliana R.M. Schust., Phytologia 53:365. 1983. TYPE: FLORIDA. HILLSBOROUGH CO.: Hillsborough River, in Hillsborough River State Park, *Schuster 83-1003*.

Hillsborough Co.: Hillsborough River State Park, rapids area, near water's edge, growing on stump, 25 Jan 1957, *s.c. 9A* (NY); Hillsborough River, in Hillsborough River State Park, *Schuster 33903, 33910a* (Schuster 1992a).

Frullania taxodiocola R.M. Schust., Phytologia 53:364. 1983. TYPE: FLORIDA. MONROE CO.: between Monroe Station and Ochopee, just N of Tamiami Canal, in Cypress Head, *Schuster 42241* (HOLOTYPE: F).

GEOCALYCACEAE

Chiloscyphus apalachicolus (R.M. Schust.) J.J. Engel & R.M. Schust.

Lophocolea apalachicola R.M. Schust., Hep. Anthoc. N. Amer. 4:195. 1980. TYPE: FLORIDA. JACKSON CO.: Florida Caverns State Park, Chipola River, *Schuster 67-591*.

Gadsden Co.: Aspalaga Bluff on Apalachicola River, *Schuster 33381* (Schuster 1980).

Chiloscyphus martianus (Nees) J.J. Engel & R.M. Schust.

Lophocolea martiana Nees

Collier Co.: Collier-Seminole State Park, hammock forest, base of decayed stump of *Sabal palmetto*, *Schuster 26101* (Schuster 1980). **Dixie Co.:** N of Steinhatchee, palm hardwoods swamp (Breil 1970). **Gadsden Co.:** Aspalaga Bluff along Apalachicola River (Breil 1970). **Lake Co.:** Alexander Springs, *Schuster s.n.* (Schuster 1980). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 940* (FLAS, Amoroso & Judd 1995). **Marion Co.:** Ocala National Forest, Juniper Springs, Juniper Creek, 4–5 miles below its origin in Juniper Springs, *Schuster 33400a, 33400c* (Schuster 1980). **Miami-Dade Co**: Everglades W of Miami, *Small & Nash 480* (Schuster 1980); hammocks near the Homestead Trail, between Cutler and Longview Camp, *Small & Carter 1355, 1371, 1396* (Schuster 1980); Royal Palm Hammock, Everglades National Park (Schuster 1971, 1980); McFarlin (1940); Redfearn (1952). **Pasco Co.:** Blanton, *Underwood 228* (Schuster 1980); McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on rotten logs in hammock, *Rapp 1* (Haynes 1915); Sanford, 1923, *Rapp s.n.* (Frye & Clark 1943, Schuster 1980); McFarlin (1940); Redfearn (1952). **Volusia Co.:** Port Orange, 1893, *Straub s.n.* (*Underwood & Cook, Amer. Hep. Exsic. no. 15*) (Evans 1905, Frye & Clark 1943, Schuster 1980); Redfearn (1952). **Wakulla Co.:** Wakulla Swamp, *Schornherst 2242* (Schuster 1980).

Chiloscyphus profundus (Nees) J.J. Engel & R.M. Schust.

Lophocolea heterophylla (Schrad.) Dumort., *fide* Engel & Schuster (1984).

Dixie Co.: Breil (1970). **Gadsden Co.:** Breil (1970). **Hillsborough Co.:** NW of Tampa, Country Run subdivision, on base of cypress in dry cypress swamp, 1 Jan 1985, Lassiter & *Lassiter 2124* (USF). **Jefferson Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in cypress dome, 1990–1992, *Amoroso 552, 558* (FLAS, Amoroso & Judd 1995). **Pasco Co.:** SR 54, 1.5 mi W of I-75, near Quail Hollow, on exposed large lichened cypress knee in cut-over swamp, evidence of past fire, 27 Jan 1981, *Lassiter & Lassiter 501* (USF). **Seminole Co.:** Sanford, on bark and on sandy banks, *Rapp 13* (Haynes 1915); McFarlin (1940); Redfearn (1952). **Taylor Co.:** Breil (1970). **Union Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970). **Without Co.:** Kurz & Little (1933); Frye & Clark (1943).

Chiloscyphus profundus var. **cladogynus** (R.M. Schust.) J.J. Engel

Highlands Co.: Highlands Hammock, *Schuster 76-345* Schuster (1980).

JUNGERMANNIACEAE

Schistochilopsis capitata (Hook.) Konstant.

Lophozia capitata (Hook.) Macoun

Lophozia mildeana (Gottsche) Schiffn., fide Schuster (1969).

Seminole Co.: 15 mi SW of Sanford, moist clayey bank, 24 Mar 1923, *Rapp 94* (Evans 1923, Schuster 1969); Redfearn (1952).

Solenostoma gracillimum (Sm.) R.M. Schust.

Jungermannia crenulata Sm., fide Schuster (1969).

Plectocolea crenulata (Sm.) Buch

Gadsden Co.: Breil (1970). **Wakulla Co.:** Lost Creek between Crawfordville and Arran (Kurz & Little 1933, Schuster 1969); Breil (1970). **Washington Co.:** Breil (1970). **Without Co.:** Kurz & Little (1933); Frye & Clark (1943).

Syzygiella autumnalis (DC.) K. Feldberg et al.

Jamesoniella autumnalis (DC.) Steph., fide Feldberg et al. (2010).

Bay Co.: Breil (1970). **Leon Co.:** Breil (1970). **Liberty Co.:** Torreya State Park, damp soil along Rock Creek, *Schuster 44082* (Schuster 1969); Breil (1970).

LEJEUNEACEAE

Acrolejeunea heterophylla (A. Evans) Grolle & Gradst.

Pychocoleus heterophyllus A. Evans, Amer. J. Bot. 5:144. 1918. Type: FLORIDA. Seminole Co.: Sanford, Robinson Spring, 8 mi S of Sanford, May 1917, *Rapp s.n.* (holotype: NY).

Hernando Co.: McKethan Park, N of Brooksville, on large Quercus virginiana in mesic hammock, 9 Jan 1982, Lassiter & *Lassiter 821* (USF). **Hillsborough Co.:** S of Tampa, Cockroach Bay Environmental Center, coastal hammock, mixed mangroves, on *Quercus virginiana*, 28 Oct 1984, Lassiter & *Lassiter 2154* (USF); Cockroach Bay Environmental Center, in mangrove, on *Juniperus silicicola* [*J. virginiana*], *Quercus virginiana, Avicennia germinans, Conocarpus erectus* and rotten and burned wood (Te Strake *et al.* 1986). **Lake Co.:** Alexander Springs, S of Astor Park, Ocala National Forest, on bark of *Quercus virginiana*, Dec 1953, *Schuster 31518*, on bark of *Quercus laevis*, *Schuster 31519* (Schuster 1954, Schuster 1980). **Manatee Co.:** downtown Bradenton, at extreme base of *Quercus virginiana*, 27 Jan 1985, Lassiter & *Lassiter 2069* (USF); Madira Bickel Mound, in mangrove, on *Quercus virginiana* (Te Strake *et al.* 1986). **Marion Co.:** along E Bank of Oklawaha River, at intersection of Rte. 40, ca. 5 mi E of Silver Springs, on bark, Dec 1951, *Schuster 25621* (Schuster 1954); Juniper Springs, Ocala National Forest, on bark of *Persea borbonia*, *Schuster 25789* (Schuster 1954); Juniper Springs, Ocala National Forest, on Rte. 40, dense hammock forest, over bark of large tree of *Persea borbonia*, 11 Dec 1951, *Schuster 22090* (NY, Schuster 1980). **Pasco Co.:** Salt Springs, 1 mi N of Port Richey, T25S, R16 E, Sec. 20, on Quercus near springs, 15 Mar 1981, *Lassiter & Lassiter 571* (USF). **Pinellas Co.:** Fort DeSoto State Park, on *Quercus virginiana* on N end, 14 Aug 1982, Lassiter *et al.* *777* (USF). **Seminole Co.:** Sanford, on bark, May 1912, *Rapp 38* (NY, Frye & Clark 1947, Schuster 1980); 1918, *Rapp 63* (Frye & Clark 1947).

Schuster (1954, 1980) stated that this is an "old tropical species" which invaded Florida in pre-Pleistocene times but has not spread in more recent times, and is restricted to an Oligocene Island Region.

Caudalejeunea lehmanniana (Gottsche) A. Evans

Collier Co.: Collier-Seminole State Park, *Schuster 26130a* (G, Schuster 1980, Gradstein 1994); Collier-Seminole State Park, *Schuster 20428, 26148* (NY, Gradstein 1994). **Dixie Co.:** near Long Prairie, hammock, Oct 1906, *Small & Carter 2812* (Evans 1911a, 1911b). **Miami-Dade Co.:** Costello Hammock near Silver Palm, on the bark of various trees, 2 Apr 1939, *McFarlin 1746* (FLAS-B1862, Frye & Clark 1947), *1748a* (FLAS-B1864, Frye & Clark 1947); Hattie Bauer Hammock near Modella, 28 Feb 1940, *McFarlin 1923* (FLAS-B1693, Frye & Clark 1947);

Timms Hammock near Silver Palm Homestead, 25 Feb 1940, on rachis of *Nephrolepis*, *McFarlin 1931* (FLAS-B1692, Frye & Clark 1947); Timms Hammock near Silver Palm Homestead, *McFarlin 1962* (FLAS-B1861, Frye & Clark 1947); Timms Hammock near Silver Palm Homestead, *McFarlin 1965* (FLAS-B1863, Frye & Clark 1947); Everglades National Park, *Small & Lowe 7041, 7044, 7059* (NY, Gradstein 1994); Everglades National Park, *Small & Moisier 5285, 6174, 6188* (US, Gradstein 1994); Everglades National Park, *Schuster 22810* (NY, Gradstein 1994); *Buck B799* (NY, Gradstein 1994); Costello Hammock near Silver Palm, 23 Mar 1938, *McFarlin 1581* (FLAS-B1726).). Additional records cited by Schuster (1980). **Seminole Co.:** Sanford, 28 Sep 1917, *Rapp s.n.* (Evans 1918); on tree trunks, *Rapp 76* (Haynes 1915, Evans 1918).

Additional specimens and locality records from Miami-Dade Co. were given by Schuster (1980).

Ceratolejeunea cubensis (Mont.) Schiffn.

Collier Co.: Royal Palm [Collier-Seminole] State Park, on rotten wood, 6 Dec 1919, *Britton & Britton 561* (NY, Frye & Clark 1947); Goodburn Hammock, 1915, *Small & Mosier 5232* (Frye & Clark 1947); Horton Hammock, 1916, *Small 7010* (Frye & Clark 1947, Schuster 1980); Timms Hammock, on Bauer Drive, near Modello, 1951, *Schuster 22857, 22915* (Schuster 1980). **Miami-Dade Co.:** Miami, n bark with moss, Nov 1904, *Small 25* (USF); on fronds of *Trichomanes krausii*, *Small s.n.* (USF-255000); between Cutler and Longview Camp, Everglades, *Small & Carter 1431* (Frye & Clark 1947); Everglades National Park, 16 Oct 1962, *Craighead s.n.* (USF-254994).

Ceratolejeunea guianensis (Nees & Mont.) Steph.

Duval Co.: 1927, *J. Kennedy 69* (Frye & Clark 1947). **Gadsden Co.:** Bainbridge Road Bridge, 1927, *Kurz 91C* (Frye & Clark 1947). **Lake Co.:** Dode Hammock, 1912, *Hook 59* (Frye & Clark 1947). **Seminole Co.:** Sanford, 1929, *Rapp 37* (Frye & Clark 1947).

Ceratolejeunea laetefusca (Austin) R.M. Schust., J. Elisha Mitchell Soc. 72:306. 1956. *Lejeunea laete-fusca* Austin, Bot. Gaz. 1: 36. 1876. LECTOTYPE: UNITED STATES. FLORIDA: 1877, *Donnell-Smith s.n.* (lectotype *fide* Schuster 1956, NY).

Ceratolejeunea integrifolia A. Evans, fide Dauphin (2003).

Alachua Co.: Devil's Millhopper, a limestone sink N of Gainesville, on bark of large sweetgum, 16 Feb 1968, *Breil 2481* (US, NY, Dauphin 2003); Devil's Millhopper Sink, on bark, 16 Feb 1968, *Griffin III s.n.* (FLAS). *6187, 6148* (US, Dauphin 2003); Hattie Bauer Hammock near Modella, on filmy fern (*Trichomanes* sp.), 28 Feb 1940, *McFarlin 1924* (FLAS-B031853); Nature Trail, Florida Community College, South Campus, Jacksonville, on bark of decaying tree with other byrophytes including *Isopterugium micans*, 14 Feb 1987, *Miller 85* (FLAS-B51669); Nature Trail, Florida Community College, South Campus, Jacksonville, exposed roots and bark of oak tree, 15 Mar 1987, *Miller 69* (FLAS-B51668). **Clay Co.:** E side of SR 21, ca. 10 mi N of Keystone Heights, upland mixed hardwoods, base of small *Prunus caroliniana* and spreading onto sandy soil, 20 Jan 1982, *White 64* (FLAS-B45777); Gold Head Branch State Park, Hwy 21, NE of Keystone Heights, sandy ravine, on trunk of hardwoods, 100 ft., 15 Sep 1971, *Griffin s.n.* (FLAS). **Duval Co.:** Shields Hammock, *Small et al. 6153* (US); Timms Hammock, *Small et al.* (FLAS-B15300). **Gadsden Co.:** Bainbridge Road Bridge, 1927, *Kurz s.n.* (Schuster 1980); Breil (1970). **Hernando Co.:** 3–4 mi NW of Brooksville, 31 Dec 1951, *Schuster 22037a* (NY). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, over bark of *Quercus virginiana*, 28 Dec 1950, *Schuster 19954d* (NY); Highlands Hammock State Park, on hard woods, 16 March 1968, *Griffin s.n.* (FLAS-013408); plants growing); on base of *Magnolia virginiana* in humid subtropical forest, 22 Jan 1972, *Griffin s.n.* (FLAS-015257); Highlands Hammock State Park, along forest trail in hardwood hammock forest, oaks and cabbage palm canopy, 18 Nov 1989, *Griffin 991* (FLAS-B54781); Highlands Hammock State Park, Wild Orange Grove trail, on fallen trunk of cabbage palm, 10 Nov 1991, *Whitehall HLD0019* (FLAS-B57456); Orange Blossom Trail, mesic hardwood forest, on exposed roots of *Carya glabra*, 16 May 1981, *Griffin 687* (FLAS-B54016);); Orange Blossom Trail, mesic hardwood forest, on exposed roots of *Carya glabra*, 16 May 1981, *Griffin 688* (FLAS-B54017); Highlands Hammock State Park, ca. 5 mi W of Sebring, open forest, on roots of *Carya glabra*, 16 Apr 1981, *Griffin 282* (FLAS-B45848); Highlands Hammock State Park, hardwoods, 16 Mar 1968, *Griffin s.n.* (FLAS-B13408). **Hillsborough Co.:** Hillsborough River State Park, rapids area, 21 Jan 1959, *Johnson 3325/3E* (NY); Hillsborough River State Park, shady hardwood forest, on base of trunk of *Quercus*, 1 Mar 1970, *Griffin s.n.* (FLAS-B13406). **Jefferson Co.:** W of Aucilla Road on Rte. 98, *Schuster 44195* (Schuster 1980). **Lake Co.:** Ocala National Forest, Alexander Springs Recreation Area, Timucuan Indian Trail, hardwood swamp, base of large hardwood tree, 22 Sep 1991, *Easley B44* (FLAS-B57157); Alexander Springs, along Timucuan Trail, hardwood swamp, on trunk of tree, 22 Sep 1991, *Fisher s.n.* (FLAS-B57183); Ocala National Forest, 5.25 mi S of Astor Park off CR 445 in Alexander Springs Recreation Area, E of Alexander Springs pool off of the Timucuan Indian Trail, T16S, R27E, Sec. 16, tropical hammock, on base of *Persea borbonia*, 22 Sep 1991, *Herring B58* (FLAS-B57057); Alexander Springs, shady, mesic hammock forest, trunk of *Carya glabra*, 24 Apr 1981, *Griffin 647* (FLAS-B54009). **Leon Co.:** Breil (1970). **Levy Co.:** Gulf Hammock, (sec. 10), *Griffin 60* (GOET, U, Dauphin 2003); Sumner Quad., Sec. 10, 29°13'00"N, 82°58'04"W (29.217, -82.968), 28 Sep 1981, *Griffin 60* (NY); Waccassasa Bay & Cedar Key Scrub State Preserves, Waccassasa Bay Quad., Sec. 34, coastal hardwood hammock, 15–20 ft., 18 Nov 1981, *Griffin 2141* (FLAS-061072); Waccassasa Bay & Cedar Key Scrub State Preserves, Bronson SW Quad., Sec. 2[illegible] *Taxodium*-hardwood swamp forest, 15–20 ft., on trunk of *Quercus hemisphaerica* [*Q. laurifolia*], 18 Nov 1981, *Griffin 2167* (FLAS-061030); Waccassasa Bay & Cedar Key Scrub State Preserves, Sumner Quad. Sec. 10, alt. 15–20 ft., mesic hammock, 14 Oct 1981, *Griffin 2[illegible]* (FLAS-B61097); Waccassasa Bay & Cedar Key Scrub State Preserves, Sumner Quad., Sec. 29, hydric hammock, 15–20 ft., 14 Oct 198[illegible] *Griffin 2283* (FLAS-B60927); *2284* (FLAS-B60928); Waccassasa Bay & Cedar Key Scrub State Preserves, Sumner Quad., Sec. 29, hyd[illegible] hammock, 15–20 ft., 14 Oct 1981, *Griffin 2284* (FLAS). Waccassasa Bay & Cedar Key Scrub State Preserves, Waccassasa Bay Quad. Sec. 3[illegible] coastal hardwood hammock, 15–20 ft., 18 Nov 1981, *Griffin 2141* (FLAS-B61072). **Liberty Co.:** Breil (1970). **Marion Co.:** along FL 40 just W of bridge over Ochlawaha River, in hydric forest, at base of *Liquidambar styraciflua*, *Griffin 365* (FLAS-046955). **Miami-Dade Co.:** Murd[illegible]

Hammock, 22 Jun 1915, *Small et al. 6208* (NY); Hattie Bauer Hammock near Modella, on filmy fern (*Trichomanes* sp.), 28 Feb1940, *McFarlin 1924* (FLAS-B31853). **Orange Co.:** Rock Springs, horizontal stem, 80 ft., 31 Mar 1969, *Griffin s.n.* (FLAS-B13407). **Polk Co.:** Reedy Creek Swamp, 24 Feb 1940, *McFarlin 54* (FLAS-B1644). **Seminole Co.:** Sanford, on trunks of trees and exposed roots, *Rapp 37* (Haynes 1915, Schuster 1980), various numbers (Evans 1911b); Sanford, *Rapp 362* (US, Dauphin 2003), Apr 1934, *Rapp s.n.* (NY), on stump, 6 Apr 1917, *Rapp s.n.* (FLAS-B5141), on bark, *Rapp s.n.* (FLAS-B7124); road to Oviedo, Mar 1923, *Rapp s.n.* (FLAS-B7363); Sylvan Lake, with *Metzgeria*, Feb 1917, *Rapp s.n.* (FLAS-B7364), on various bark, spring 1936, *Rapp s.n.* (FLAS-B7125); Sanford, on tree trunk, Apr 1934, Rapp s.n. (FLAS-B37711). **Volusia Co.:** Orange City, *Hood s.n.* (Schuster 1980). **Wakulla Co.:** floodplain of Ochlockonee River, at base of sweetbay, 1 Feb 1968, *Breil 2460* (NY). **Washington Co.:** Moss Hill, behind Methodist Church, *Breil 2535* (US, Dauphin 2003); *s.c.*, *s.n.* (Breil 1970). **without locality**: the lectotype.

Ceratolejeunea rubiginosa Steph.

Miami-Dade Co.: between Cutler and Longview Camp, N of Homestead, *Small & Carter 1431* (Fulford 1945, Schuster 1980); near Longview Camp, *Small & Wilson 1527* (Fulford 1945, Schuster 1980). **Without Co.:** Fulford (1945); Frye & Clark 1947).

This species was reported from Florida by Fulford (1945) and Schuster (1980) apparently based on the same specimens.

Cheilolejeunea adnata (Kunze ex Lehm.) Grolle

Cheilolejeunea decidua (Spruce) A. Evans

Miami-Dade Co.: Freeman Hammock, Arch Creek Prairie, 3 Jul 1915, *Small & Mosier 6162* (NY); Timms Hammock near Silver Palm, Homestead, 24 Feb 1940, *McFarlin 1954* (FLAS); Timms Hammock, 19 Jun 1915, *Small & Mosier 5920* (NY); Coconut Grove, 1916, *Small 7414* (Schuster 1980); Miami, 1904, *Howe 81* (Schuster 1980); Royal Palm State Park, 1919, *Britton & Britton 564* (Evans 1905, Frye & Clark 1947, Schuster 1980); Timms Hammock, 19 Jun 1915, *Small & Mosier 5920* (NY); Timms Hammock near Silver Pal, Homested, 24 Feb 1940, *McFarlin 1954* (FLAS-B1689).

Cheilolejeunea clausa (Nees & Mont.) R.M. Schust.

Cheilolejeunea myriantha (Nees & Mont.) R.M. Schust., Hep. Anthoc. N. Amer. 4:871. 1980, *fide* Thiers in prep.

Euosmolejeunea clausa (Nees & Mont.) A. Evans

Alachua Co.: Gainesville, Magnesia Spring, on tree, 10 Jul 1938, *Rapp s.n.* (FLAS-B7130); Gainesville, Hatchet Creek, Jan 1933, *Little s.n.* (FLAS-536). **Bay Co.:** Breil (1970). **Citrus Co.:** Yulee Sugar Mill, Homosassa, 4 Apr 1953, *Breen 3057* (NY). **Collier Co.:** Big Cypress Swamp, 22 Feb 1935, *McFarlin & Grout 1001B* (FLAS, Frye & Clark 1947); ca. 13 mi W of Miami-Dade-Collier County line along Tamiami Trail, dense swamp, decaying wood, 8 Mar 1957, *Breen 3050* (NY); Fakahatchee Strand, between Deep Lake and Alligator Alley along Fla 29, subtropical swamp with royal palms, on trunk of *Taxodium distichum*, 27 Mar 1982, *Griffin 922* (FLAS-054339); in Kissimmee Billie Swamp, 20 mi E of Immokalee, 14 Apr 1938, *McFarlin 1558* (FLAS-1965); Torreya State Park, 10 Nov 1937, *McFarlin 1491* (FLAS-B1657); about); ca. 4 mi SW of Monroe Station on "Loop Road," "Gator Hook slough," cypress swamp-pond-apple area and bordering gladeland, on fronds of *Trichomanes holopterum*, 5 Jun 1966, *Long et al. 1688b* (USF-254991). **Dixie Co.:** Breil (1970). **Escambia Co.:** Escambia River at Molino, 3 Apr–13 Jun 1953, *Breen 3827* (NY). **Gadsden Co.:** Chattahoochee Ravine, over soft limestone, 27 Mar 1927, *Kurz 136* (NY). **Hernando Co.:** U.S. 41 & SR 476, N of Brooksville, in mats on large *Juniperus silicicola* [*J. virginiana*] in mesic woods, 2 May 1984, *Lassiter & Gross 828* (USF). **Highlands Co.:** Highlands Hammock State Park, near Sebring, subtropical rainforest, 11 Aug, 1985, *Thiers 3147* (NY). **Hillsborough Co.:** Hillsborough River State Park, 21 Jan 1955, *Johnson s.n.* (NY). **Jackson Co.:** Chipola River bridge, 1 mi E of Marianna, limestone cliff, 27 Mar 1927, *Kurz 138* (NY). **Jefferson Co.:** Monticello, 4 Feb 1890, *Lighthipe 7* (NY); Rock Bluff, 10 Nov 1937, *McFarlin 1447* (FLAS-1655). **Lake Co.:** Orange Bend, Jan–Apr 1891, *Underwood 2200* (NY). **Leon Co.:** Tallahassee, Caldwell's Woods, on *Magnolia grandiflora*, 20 Feb 1952, *Breen 2684* (NY); Breil (1970). **Levy Co.:** N of Cedar Key, along SR 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 682, 683, 679, 1098* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Talogia River swamp, 18 Sep 1938, *Breen 1006* (NY); Torreya State Park, 10 Nov 1937, *McFarlin 1491* (FLAS); Alum Bluff, *McFarlin 1588* (FLAS); Johnson's Juniper Swamp ca. 8 mi S from Bristol, 9 Nov 1937, *McFarlin 1688* (FLAS-1659); Alum Bluff, *McFarlin 1588* (FLAS-1963) (Breil 1970). **Manatee Co.:** Jan–Apr 1891, *Underwood 2019* (NY). **Marion Co.:** Rainbow Springs, high bank S of waterfall, 26 Jul 1952, *Breen 2867* (NY). **Miami-Dade Co.:** between Cutler and Longview Camp, in hammocks near Homestead Road, 9–12 Nov 1903, *Small et al. 1415* (NY); Miami, on bark with moss, Nov 1894, *Small 24* (USF); Coconut Grove, 1916, *Small 7815* (Frye & Clark 1947); Everglades National Park, Royal Palm Hammock (Paradise Key), *Schuster 19903, 22610* (Schuster 1980). **Monroe Co.:** hammocks S of Coot Bay, 1 Apr 1916, *Small 7551* (NY). **Orange Co.:** Econlockhatchee River, near Bithlo, *Taxodium* swamp, on bark, 3 Apr 1981, *Düll 44/1a* (NY). **Palm Beach Co.:** about Boca Raton Lake, below Delray, 19 Nov 1903, *Small 1434* (NY). **Polk Co.:** Fort Meade, Jan–Apr 1890, *Smith s.n.* (NY); Lakeland, highland gully, 15 Jan 1931, *McFarlin 115* (FLAS-1660). **Seminole Co.:** Sanford, on bark, Mar 1913, *Rapp 20* (NY, Haynes 1915, Frye & Clark 1947); Sanford, Apr 1915, *Rapp s.n.* (FLAS-5144); Sanford, 1916, *Rapp s.n.* (FLAS-B6748); Sanford, hammock, on bark, 24 Jan 1931, *Rapp s.n.* (FLAS-B6951); Sanford, hammock, 23 Feb 1934, *Rapp s.n.* (FLAS-B6950); Sanford, Mar 1934, *Rapp s.n.* (FLAS-B6952); Sanford, on trees, 1916, *Rapp s.n.* (FLAS-B6748). **Sumter Co.:** 15 mi W of Leesburg, virgin hardwood hammock, on base of live oak, 12 Aug 1957, *Kral 5410* (NY). **Volusia Co.:** Enterprise, s.d., *Foster s.n.* (NY). **Wakulla Co.:** opposite entrance to Wakulla Springs, limestone region in pine sandridge, on oak, 8 Mar 1967, *Breil 1715* (NY, Breil 1970). **Washington Co.:** Rock Hill, ca. 4 mi S of Chipley (Breil 1970, Schuster 1980).

Cheilolejeunea discoidea (Lehm. & Lindenb.) Kachroo & R.M. Schust.

Cheilolejeunea parvula (A. Evans) Breil

Euosmolejeunea parvula A. Evans, Amer. J. Bot. 5:141. 1918. TYPE: FLORIDA. SEMINOLE CO.: Sanford, Jan 1917, *Rapp 86* (HOLOTYPE: US).

Marion Co.: Ocala, Jan–Apr 1891, *Underwood 1750* (NY). **Seminole Co.:** Sanford Robinson Spring, 8 mi S of Sanford, *Rapp 86a* (Evans 1918, Frye & Clark 1947). **Washington Co.:** Rock Hill, 9 mi S of Chipley, pine savanna hill with sandstone outgroups, on sandstone, 12 May 1967, *Breil 1710* (NY); 4 mi S of Chipley, Rock Hill (Breil 1970).

Cheilolejeunea polyantha A. Evans, Bull. Torrey Bot. Club 8:141. 1902. TYPE: FLORIDA. LAKE CO.: Eustis, Jan–Apr 1891, *Underwood 1380* (HOLOTYPE: NY).

Collier Co.: Fakahatchee Strand State Preserve, along Janes Memorial Scenic Drive, ca. 2 mi NNW of Ranger Station, *Taxodium*-hardwood swamp, 4 Mar 2009, *Buck 54447* (NY). **Highlands Co.:** Highlands Hammock State Park, bark of living tree, 10 Mar 1962, *Conard s.n.* (NY). **Hillborough Co.:** Hillsborough River State Park, *Schuster 33936* (Schuster 1980). **Leon Co.:** Tallahassee, Caldwell's Woods, on *Magnolia grandiflora*, 2 Jan 1952, *Breen 2639* (NY). **Liberty Co.:** Hardaway Tract, base of tree, 18 Jun 1939, *Breen 374* (NY). **Marion Co.:** near Kerr City, white sand scrub, 10 Aug 1985, *Thiers 3134* (NY). **Miami-Dade Co.:** hammocks near Longview Camp, 13–16 May 1904, *Small & Wilson 2057* (NY); Everglades, Paradise Key (Royal Palm Hammock), *Schuster 19928b* (Schuster 1980). **Monroe Co.:** 2 mi N of Tamiami Canal, between Monroe Station and Ochopee, *Schuster 42241a, 42243a, 42243c* (Schuster 1980). **Polk Co.:** Nalcrest, W of recreation areas, low pineland, *Magnolia virginiana*, 26 Nov 1988, *Wheeler, s.n.*). **Seminole Co.:** Sanford, on trees, 19 Mar 1912, *Rapp 61* (Haynes 1915; NY, Frye & Clark 1947); Sanford, on trees, 16 Nov 1934, *Rapp s.n.* (FLAS-B5406); Sanford, on trees, 21 Nov 1934, *Rapp s.n.* (FLAS-B5407); Sanford, on *Andromeda*, 15 Jan 1919, *Rapp s.n.* (FLAS-B7126); Sanford, on trees, *Rapp s.n.* (FLAS-B6741).

This species is restricted to central and southern Florida (Schuster 1980; Thiers in prep.).

Cheilolejeunea polyantha var. **caduciloba** R.M. Schust., Hep. Anthoc. N. Amer. 4:887. 1980. TYPE: USA. FLORIDA: HILLSBOROUGH CO.: Hillsborough River State Park, moist hammock forest along Hillsborough River, on bark of *Carpinus*, *Schuster 33915pp.*

Collier Co.: Royal Palm Hammock N of Tamiami Canal, N of Collier-Seminole State Park, on *Roystonea elata* base, *Schuster 44360* (Schuster 1980). **Highlands Co.:** Highlands Hammock State park, 6 mi W of Sebring, 28 Dec 1950, *Schuster 20112* (NY). **Hillsborough Co.:** Hillsborough State Park, *Schuster 33915, 33936, 33938* (Schuster 1980). **Marion Co.:** Ocala National Forest, Juniper Creek, 2–3 mi below Juniper Springs, *Schuster 33391, 33395e* (Schuster 1980). **Miami-Dade Co.:** Redlands Hammock, 3 mi NW of Homestead, 30 Dec 1953, *Breen 3243* (NY); Everglades National Park, Everglade Keys, Sect. 24 of Long Pine Key, deep hammock, *Schuster 22021* (Schuster 1980). **Monroe Co.:** 2 mi N of Tamiami Trail, between Monroe Sta. and Ochopee, *Schuster 42243a* (Schuster 1980). **Seminole Co.:** Sanford, Ronbinson Springs, *Rapp s.n* (FLAS-B6741).

According to Thiers (in prep.) this variety extends from South Florida to Georgia and Louisiana, but is unknown outside North America.

Cheilolejeunea rigidula (Nees & Mont.) R.M. Schust.

Euosmolejeunea duriuscula (Nees & Mont.) R.M. Schust.

Euosmolejeunea rigidula (Nees & Mont.) A. Evans

Alachua Co.: Devil's Millhopper, base of trunk of *Carpinus caroliniana*, 5 May 1972, *Buck s.n.* (NY); 3 mi E of Gainesville, bayhead, 24 Apr 1950, *Redfearn 182* (FLAS); Devil's Millhopper, 27 Feb 1950, *Redfearn 148* (FLAS); Gainesville, 1938, *Murrill s.n.* (Frye & Clark 1947). **Bay Co.:** Breil (1970). **Calhoun Co.:** Breil (1970). **Citrus Co.:** lime-sink near Pineola, 14 Dec 1918, *Small 8927* (NY). **Clay Co.:** Gold Head Branch State Park, *Schuster 37218* (Schuster 1980). **Collier Co.:** Royal Palm Hammock State Park, dense hammock forest, over thin reddish, loose bark, 19–21 Dec 1950, *Schuster 20418* (NY); about 4 mi SW Monroe Station on "Loop Road," "Gator Hook slough," cypress swamp-pond-apple area and bordering gladeland, with *Lejeunea laetevirens*, on fronds of *Trichomanes holopterum*, 5 Jun 1966, *Long et al. 1688c* (USF-75139). **Columbia Co.:** 2 mi W of Santa Fe River, 30 Jan 1943, *Breen 2130* (NY); Breil (1970). **Dixie Co.:** Breil (1970). **Escambia Co.:** Gonzalez, lower bluff, Escambia River, at base of tree, 24 Nov 1951, *Redfearn 2592* (NY). **Gadsden Co.:** Apalachicola River floodplain at Aspalaga Bluff on Liberty and Gadsden Co. line, on oak, 9 May 1967, *Breil 1592* (NY); Breil (1970). **Gilchrist Co.:** Breil (1970). **Hendry Co.:** Brown's Camp, Big Cypress Seminole Indian Reservation, 24 Jan 1952, *Brass 21505A* (NY). **Hernando Co.:** 3–4 mi NW of Brooksville, *Schuster 22061a, 22100b, 22110d* (Schuster 1980). **Highlands Co.:** Sebring, 1934, *McFarlin 1157, 1165, 1167 1169, 1187, 1191, 1222, 1223, 112*[illegible] (Frye & Clark 1947); Highlands Hammock State Park, near Sebring, over bark, 28 Dec 1950, *Schuster 19954c* (NY). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 22862, 22859, 33910a, 33940a* (Schuster 1980). **Indian River Co.:** Sebastian, on sand, 2 Dec 1919 *Britton & Britton 634a* (NY). **Jackson Co.:** Florida Caverns State Park, near Chipola River, *Schuster 44134b* (Schuster 1980); Breil (1970). **Jefferson Co.:** Wacissa at headwaters of Wacissa River, hammock, trunk of maple over water, 5 May 1967, *Breil 1700* (NY); Breil (1970). **Lake Co.:** Eustis, Jan 1891, *Underwood s.n.* (NY). **Leon Co.:** Tallahassee, intersection of Gum Road and Capital Circle, *Nyssa* swamp, at base of *Nyssa*, 18 Jul 1967, *Breil 1842* (NY); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp and scrub, 1990–1992, *Amoroso 685* (FLAS, Amoroso & Judd 1995); Waccassasa Bay Quad., Sec. 34, coastal hammock, on exposed root of *Quercus virginiana*, 11 Mar 1982, *Griffin 379* (NY). **Liberty Co.:** Talogia River swamp, 18 Sep 1938, *s.c. 1009* (NY); along State Road 18, near Bristol, in ravine, 10 Nov 1937, *McFarlin 1546* (FLAS-1852); Rock Bluff, 10 Nov 1937, *McFarlin 1446* (FLAS-1678),); Torreya State Park, 10

Nov 1937, *McFarlin 1483* (FLAS-1853); Torreya State Park, 10 Nov 1937, *McFarlin 1468* (FLAS-1967). Breil (1970). **Manatee Co.:** Myakka City, 21 Mar 1931, *McFarlin 458* (FLAS-B1975). **Marion Co.:** Ocala National Forest, Silver Glen Springs, *Schuster 42201* (Schuster 1980). **Miami-Dade Co.:** Hattie Bauer Hammock, 16 Mar 1915, *Small & Mosier 5120a* (NY); Hattie Bauer Hammock near Modella, 28 Feb 1940, *McFarlin 192* (FLAS-B1693). Miami, on bark, with moss, Nov 1894, *Small 23* (USF); Cuthbert Lake, 1916, *Small 7548* (Frye & Clark 1947); Everglades National Park, Long Key pineland, Sec. 12 & 24, *Schuster 22022a, 22055, 22145d* (Schuster 1980). **Monroe Co.:** Everglades National Park, Wilderness Waterway; S of Cabbage Island, near Marker 28, large mats on large *Concarpus erectus* in partial shade, 6 May 1983, *Lassiter & Lassiter 717* (USF); Flamingo-Cape Sable, hammocks, 26 Nov 1916, *Small 7812* (NY, Frye & Clark 1947). **Orange Co.:** Rock Springs Park, 27 Jan 1947, *Schallert s.n.* (FLAS). **Pasco Co.:** Blanton, *Underwood & Cook 135* (FLAS); Blanton, Feb 1891, *Underwood 225* (NY). **Polk Co.:** Clark's Pool near Lakeland, 18 Dec 1948, *Sharp & Redfern s.n.* (NY); Kissenger Springs, 15 Oct 1930, *McFarlin 16* (FLAS-B2024). **Sarasota Co.:** Myakka State Park, 31 Jul 1952, *Breen 2834* (NY). **Seminole Co.:** Sanford, 19 Apr 1913, *Rapp 23* (NY, Frye & Clark 1947); Sanford, on bark, *Rapp 23* (Haynes 1915); Sanford, Spring 1936, *Rapp s.n.* (FLAS-B7125). **Suwannee Co.:** *s.c., s.n.* (Breil 1970). **Taylor Co.:** *s.c., s.n.* (Breil 1970). **Union Co.:** Rt. 231 at bridge of Swift Creek in mixed hardwoods, at base of oak, 13 Jan 1967, *Breil 1097* (NY); *s.c., s.n.* (Breil 1970). **Wakulla Co.:** fallen magnolia, 14 May 1927, *Kurz 186a* (NY); *s.c., s.n.* (Breil 1970).**Walton Co.:** 7 mi W of Freeport, 9 Jun 1949, *Breen 2502* (NY); *s.c., s.n.* (Breil 1970). **Washington Co.:** *s.c., s.n.* (Breil 1970).

Additional specimens and localities from several counties cited above were provided by Schuster (1980).

Cheilolejeunea trifaria (Reinw. et al.) Mizut.

Collier Co.: Collier-Seminole State Park, dense hammock forest, at base of trees, 26 Dec 1952, *Schuster 26134* (NY).

This species is closely related to *C. clausa* (Thiers in prep.).

Cololejeunea cardiocarpa (Mont.) Steph.

Cololejeunea jooriana (Austin) A. Evans, *fide* Reiner-Drehwald (1994a).

Leptocolea cardiocarpa (Mont.) A. Evans

Leptocolea jooriana (Austin) A. Evans

Bay Co.: Breil (1970). **Clay Co.:** ravine at Gold Head Branch State Park, on *Magnolia grandiflora*, 7 Sep 1958, *Smith s.n.* (NY). **Collier Co.:** Collier-Seminole State Park (Schuster 1980); Rte. 94, 1 mi W of Miami-Dade Co. line & 3 mi S of Monroe Station (Schuster 1980). **Columbia Co.:** Breil (1970). **Hernando Co.:** NW of Brooksville (Schuster 1980). **Highlands Co.:** Sebring, Florida Botanical Garden, opposite Record House,1 Feb 1940, *McFarlin s.n.* (FLAS); Highlands Hammock State Park, on *Sabal palmetto*, 7 Jul 1958, *Smith 17* (NY). **Hillsborough Co.:** Hillsborough River State Park, on palm base in area of central pond, 1 Jun 1977, *Merner s.n.* (USF). **Holmes Co.:** Westville, on US 90, slash pine forest, on smooth bark of dead tree, 22 Sep 1967, *Breil 2036* (NY); Breil (1970). **Jefferson Co.:** W of Aucilla, Rte. 98, *Schuster 44189* (Schuster 1980); Breil (1970). **Lake Co.:** Ocala National Forest, Alexander Springs, *Schuster 3316b* (Schuster 1980). **Leon Co.:** St. Augustine Road, 4 Nov 1944, *Breen 2367A* (NY); Breil (1970). **Levy Co.:** Manatee Springs State Park, Suwannee River near Chiefland, *Schuster 44225f* (Schuster 1980). **Liberty Co.:** Apalachicola River, Alum Bluff, *Schuster 33527, 33536* (Schuster 1980). **Marion Co.:** Ocala National Forest, Juniper Springs Recreation Area, ca. 5 mi W of FL 19 on US 40, hardwood swamp, on palmetto trees, 10 Aug 1985, *Buck 13196* (NY). **Miami-Dade Co.:** Everglades National Park, hammock on Loveland Road, 5–6 mi W of Florida City (Schuster 1980); Paradise Key (Schuster 1980); hammock in Sect. 24, Long Key pineland and Osteen Hammock, 3–4 mi NW of Paradise Key, *Schuster 36833, 36834a, 36801, 44467a* (Schuster 1980). **Nassau Co.:** Fort Clinch State Park (Schuster 1980). **Liberty Co.:** Breil (1970). **Seminole Co.:** Sanford, at Chase, Sanford Ave., on *Myrica*, exposed roots, 8 May 1920, *Rapp s.n.* (FLAS); Sanford, on bark, Nov 1914, *Rapp 27* (NY); Sanford, on shrubs, *Rapp 5* (Haynes 1915); Sanford 1918, *Rapp 92* (Frye & Clark 1947); Sanford, at Chase, Sanford Ave., on Myrica, exposed roots, 8 MAY 1920, *Rapp s.n.* (FLAS-B6612); Sebring, Florida Botanical Garden, opposite Record House,1 FEB 1940, *McFarlin s.n.* (FLAS-B1646). **Volusia Co.:** Oak Hill, on living *Citrus* leaves, 10 Apr 1949, *Knorr s.n.* (NY). **Wakulla Co.:** Breil (1970).

Cololejeunea clavatopapillata Steph.

Aphanolejeunea clavatopapillata (Steph.) M.E. Reiner

Aphanolejeunea tuberculata (A. Evans) R.M. Schust.

Cololejeunea cristallina Herzog, fide Reiner-Drehwald (1995b).

Cololejeunea fadenii Pócs, fide Pócs & Lücking (1997).

Cololejeunea tuberculata A. Evans, Bryologist 18:84. 1915. TYPE: FLORIDA. MIAMI-DADE CO.: on Nixon-Lewis Hammock, on leaves of *Trichomanes krausii*, 16 Mar 1915, Small & Mosier 5250 (HOLOTYPE: NY), fide Reiner-Drehwald (1995b).

Alachua Co.: Creek "C," Gainesville, Oct 1932, *Little s.n.* (FLAS); Gainesville, 1939, *McFarlin 1866* (Frye & Clark 1947, Schuster 1980); Creek "C," Gainesville, Oct 1932, *Little s.n.* (FLAS-B531). **Hernando Co.:** N side of State Road 50, 0.5 mi W of Sumter Co. line, on fronds of *Trichomanes petersii*, 18 Jan 1990, *Scudder 616* (USF-254997). **Leon Co.:** 4 mi W of Tallahassee on Old Spanish Trail (Kurz & Little 1933, Schuster 1980). **Miami-Dade Co.:** Hattie Bauer Hammock, on leaves of *Trichomanes punctatum* subsp. *floridanum*, 12 Jul 1915, *Small et al. s.n.* (USF-254999); Everglades National Park, on leaves of *Trichomanes punctatum* subsp. *floridanum*, 16 Oct 1962, *Craighead s.n.* (USF-255001); Nixon-Lewis Hammock, on fronds of *Trichomanes krausii*, 31 Jan 1916, *Small 7411* (USF-254995). **Sumter Co.:** 7 mi SE of Floral City, in hammocks, on sides of rocks, on leaves of *Trichomanes punctatum* subsp. *floridanum*, 2 Jan 1954, *Garret s.n.* (USF-254998); Indian Field Ledges W of Withlacoochee River off SR 48, hammock of interspersed flat limestone outcrops with overhead of oak association, on leaves of

Trichomanes punctatum subsp. *floridanum*, 21 Sep 1963, *Lakela 26474* (USF-255002); "Rt.); "Rte. 50 Hammock," ca. 0.5 mi N & E of a northward bend in Rt. 50, oak hammock, on fronds of *Trichomanes petersii* growing on oak, 11 Aug 1985, *Nauman et al. 1625a* (USF-254996).

Cololejeunea clavatopapillata seems the most common epiphyll in Florida.

Cololejeunea contractiloba A. Evans, Amer. J. Bot. 5:131. 1918. Type: FLORIDA. Seminole Co.: Sanford, 28 Sep 1913, *Rapp s.n.*

Aphanolejeunea contractiloba (A. Evans) R.M. Schust.

Alachua Co.: "Buzzard's Roost" and Devil's Millhopper, NW of Gainesville, *Schuster 33486a* (Schuster 1980). **Bay Co.:** Breil (1970). **Citrus Co.:** Pineola, limestone grottoes (Schuster 1980). **Clay Co.:** Gold Head Branch State Park (Schuster 1980). **Gadsden Co.:** Breil (1970). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44275* (Schuster 1980). **Hillsborough Co.:** Hillsborough River State Park (Schuster 1980). **Jefferson Co.:** W of Aucilla Road, hammock forest, *Schuster 44189, 44190* (Schuster 1980). **Liberty Co.:** Apalachicola River, Alum Bluff (Schuster 1980); Breil (1970). **Marion Co.:** Oklawaha River, 4 mi E of Silver Springs, on Rte. 40, swamp, over bark on *Taxodium distichum*, 21 Dec 1951, *Schuster 22457* (NY). **Miami-Dade Co.:** Ross Hammock, N of Homestead, *Schuster 33801pp* (Schuster 1980). **Seminole Co.:** Big Tree County Park, ca. 3 mi N of Fern Park, in damp hammock forest, 23 Dec 1958, *Schuster 42181a* (NY); Sanford, 1918, *Rapp 76* (Frye & Clark 1947).

Cololejeunea cornutissima (R.M. Schust.) Stotler & Crand.-Stotl.

Aphanolejeunea cornutissima R.M. Schust.

Aphanolejeunea evansii R.M. Schust., J. Elisha Mitchell Sci. Soc. 71:134. 1955; non *A. evansii* Herzog, 1942. Type: FLORIDA. Miami-Dade Co: Homestead, N of Bauer Drive, in limesink in deepest part of Timms Hammock, 27 Dec 1954, Schuster 33701 (holotype: Hb. Schuster; isotypes: DUKE, NICH, NY).

Clay Co.: Gold Head Branch State Park, *Schuster 37207* (Schuster 1980). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 33921* (Schuster 1980). **Miami-Dade Co.:** Homestead, N of Bauer Drive, over leaf of *Tectaria minima*, in limesink, Timms Hammock, 27 Dec 1954, *Schuster 33702* (Schuster 1955); Everglade Key, Everglades National Park, Paradise Key, *Schuster 33850b* (Schuster 1955); Everglade Key, Everglades National Park, Long Key pineland, Sec. 24, in hammock, *Schuster 22029* (Schuster 1955). **Seminole Co.:** Big Tree County Park, 3 mi N of Fern Park, *Schuster 42161a, 42156, 42184* (Schuster 1980); Sanford, St. Hammock, Nov 1917, *Rapp s.n.* (FLAS-B7376, under *A. evansi*).

Cololejeunea diaphana A. Evans, Bull. Torrey Bot. Club 32:184. 1905. Type: FLORIDA. Miami-Dade Co.: near the Homestead Road, between Cutler and Longview Camp, 9–12 Nov 1903, *Small & Carter 1365* (*fide* Pócs & Lücking 1997 holotype: NY).

Aphanolejeunea diaphana (A. Evans) R.M. Schust.; non Herzog

Aphanolejeunea diaphana var. *cristulata* (R.M. Schust.) R.M. Schust.

Aphanolejeunea subdiaphana (Ast) Pócs

Aphanolejeunea subdiaphana var. *cristulata* (R.M. Schust.) Pócs

Cololejeunea diaphana var. *cristulata* R.M. Schust., J. Elisha Mitchell Sci. Soc. 72:112. 1956. Type: FLORIDA. Lake Co.: Alexander Springs, S of Miami, in hammocks near the Homestead Trail, between Cutler and Camp Longview, *Small & Carter 1365 pp.* (*fide* Pócs & Lücking 1997).

Cololejeunea subdiaphana Jovet-Ast

Cololejeunea truncatifolia (Horik.) Mizut., *fide* Pócs & Bernecker (2009).

Alachua Co.: Gainesville, *Nelson & Little s.n.* (Schuster 1980). **Clay Co.:** Gold Head Branch State Park, *Schuster 31404, 31407, 37027b* (Schuster 1956, 1980). **Collier Co.:** Collier-Seminole State Park, 1 mi N of Tamiami Canal, low, wet hammock, *Schuster 44378* (Schuster 1980). **Hernando Co.:** Annutteliga Hammock, on *Trichomanes petersii*, 10 Apr 1936, *St. John et al. s.n.* (NY); Annutteliga Hammock (Schuster 1980). **Highlands Co.:** Sebring, 1939, *Mcfarlin s.n.* (Frye & Clark 1947); Highlands Hammock State Park, W of Sebring, *Schuster 26011* (Schuster 1956); Sebring, *McFarlin s.n.* (Schuster 1956); Highlands Hammock State Park, at Florida Botanical Garden, Sebring; on bark of *Gordonia*, 2/1/40, *McFarlin s.n.* (FLAS-B871); Highlands Hammock State Park, Sebring, 5 Jul 1939, *McFarlin "A"* (FLAS-B1645).). **Hillsborough Co.:** Hillsborough River State park, 28 Jan 1957, *s.c. 28* (NY). **Leon Co.:** Tallahassee, Caldwell's Woods, on wood, 3 Oct 1951, *Breen 2591* (NY). **Liberty Co.:** Apalachicola River, Alum Bluff, on small twigs in shaded, damp ravine (Schuster 1980). **Marion Co.:** 3–4 mi below Juniper Springs, on Juniper Creek, Ocala National Forest, *Schuster 33450a, 33396* (Schuster 1956); Juniper Springs, Ocala National Forest , *Schuster 31915* (Schuster 1956); Ocala National Forest, Juniper Springs, on bark of *Quercus nigra*, and 3–4 mi below Juniper Springs along Juniper Creek (Schuster 1980). **Miami-Dade Co.:** near the Homestead road, between Longview Camp, in hammocks, 9–12 Nov 1903, *Small & Carter 1370* (Evans 1905); Hattie Bauer Hammock, Everglade Key, 18 Mar 1915, *Small & Mosier 6003* (NY); ca. 3 mi W of Homestead, Fuchs Hammock, original hammock area mixed subtropical hardwoods, numerous sinkholes, on fronds of *Trichomanes krausii*, 26 Jun 1966, *Long et al. 1926a* (USF); between Cutler and Longview Camp, *Small & Carter 1370* (Evans 1905); Mathesson Hammock, *Schuster 22692, 22680, 33976* (Schuster 1956); Costello Hammock, near Silver Palm, *Schuster 22932* (Schuster 1956); Ross Hammock, N of Homestead, *Schuster 33800a* (Schuster 1956).**Seminole Co.:** Sanford, *Rapp s.n.* (Schuster 1956, 1980); Sanford, on bark, 4 Oct 1917, *Rapp s.n.* (FLAS-B6613); Sanford, Sylvan Lake, on bark, 4 Oct 1917, *Rapp s.n.* (FLAS-B6610). Sanford, Sanford Range, on bark, 1 Nov 1939, *Rapp s.n.* (FLAS-B6611).

Cololejeunea minuscula Pócs

Aphanolejeunea minuta R.M. Schust., Hep. Anthoc. N. Amer. 4:1310. 1980. Type: FLORIDA. Highlands Co.: W of Sebring, Highlands Hammock State Park, 9 Jan 1976, *Schuster 76-319* (NY).

Highlands Co.: *Schuster 44278a, 33277, 44284* (Schuster 1980).

The species is known from Florida and Peru (Pócs & Bernecker 2009). Schuster (1980) cited several collections from the type locality of *A. minuta*.

Cololejeunea minutissima (Sm.) Schiffn. subsp. **minutissima**

Alachua Co.: Devil's Millhopper, dry groundwood, 29 Apr 1972, *Buck s.n.* (NY). **Brevard Co.:** Melbourne, along Bluff Walk, Indian River, 24 Dec 1953, *Breen s.n.* (NY). **Collier Co.:** Naples, 1934, *McFarlin & Grout 1046* (Frye & Clark 1947). **Escambia Co.:** Santa Rosa National Monument, *McFarlin 1993, 1999* (Frye & Clark 1947). **Glades Co.:** Ortona Cemetery, N of SR 78, 1 mi E of CR 78A, oak-palmetto scrub directly N of cemetery, on base of oak, 6 Mar 2009, *Buck 54491* (NY). **Highlands Co.:** Highlands Hammock State park, near Sebring, subtropical rainforest, 11 Aug 1985, *Thiers 3167* (NY); Lake Istokpoga, *McFarlin 1354, 1366* (Frye & Clark 1947). **Hillsborough Co.:** Hillsborough River State Park, 21 Jan 1960, *Johnson 23* (NY). **Jackson Co.:** Black Spring, ca. 1 mi W of FL 167, ca. 6 mi SW of Marianna, swamp forest, 3 Dec 1988, *Buck 16660* (NY). **Lake Co.:** Eldorado, Jan–Apr 1891, *Underwood 2310* (NY). **Leon Co.:** Game's woods, on live oak, 9 Aug 1944, *Breen 2319* (NY); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub, 1990–1992, *Amoroso 1113* (FLAS, Amoroso & Judd 1995). **Manatee Co.:** Feb 1891, *Underwood s.n.* (NY). **Marion Co.:** Ocala National Forest, Alexander Springs (Schuster 1980). **Miami-Dade Co.:** Paradise Key (Royal Palm Hammock), Everglades National Park, around lime sink, over exposed roots and base of tree, 24 Dec 1951, *Schuster 22558* (NY); Oklawaha Road, 4 mi E of Silver Springs, Hammock forest 5–6 mi W of Florida City, on Loveland Road, *Schuster 22561h, 22677, 22758a* (Schuster 1980). **Palm Beach Co.:** Lake Worth, 14 Mar 1891, *Underwood 2175* (NY). **Pinellas Co.:** Dunedin, 23 Apr 1954, *Earle 3343* (NY). **Polk Co.:** Clark's Pool near Lakeland, bark of oak tree, 18 Dec 1948, *Sharp s.n.* (NY). **Saint Johns Co.:** St. Augustine, Jan–Apr 1891, *Underwood 222* (NY). **Seminole Co.:** on bark, Nov 1914, *Rapp 16* (NY); Sanford, on trunk of orange, *Rapp 15* (Haynes 1915, Frye & Clark 1947). **Taylor Co.:** along Econfina River at US 98, palms, oaks cypress and palmetto common, on cypress, 24 Nov 1967, *Breil 2140* (NY). **Volusia Co.:** Orange City, Blue Spring State park, along hiking trail, pine woods grading into live oak forest, 9 Dec 1988, *Buck 16849* (NY).

Cololejeunea minutissima subsp. **myriocarpa** (Nees & Mont.) R.M. Schust.

Columbia Co.: Breil (1970). **Gilchrist Co.:** Breil (1970). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on *Quercus virginiana* in coastal hammock, bordering mixed mangrove strand, 13 Aug 1982, Lassiter & *Lassiter 856* (USF); Hillsborough River State Park, *Schuster 33909b, 33908c* (Schuster 1955); Cockroach Bay Environmental Center, in mangrove, on *Quercus virginiana*, *Sabal palmetto*, *Avicennia germinans*, *Laguncularia racemosa*, *Schinus terebenthifolia*, *Juniperus silicicola* [*J. virginiana*], living and dead *Conocarpus erectus* and rotten wood (Te Strake et al. 1986). **Jackson Co.:** Breil (1970). **Lafayette Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Manatee Co.:** Rattlesnake Key, in mangrove, on *Juniperus silicicola* [*J. virginiana*] and *Quercus virginiana* (Te Strake et al. 1986); Madira Bickel Mound, in mangrove, on dead oak (Te Strake et al. 1986). **Miami-Dade Co.:** Everglades National Park, Everglade Key, Sec. 24 of Long Key pineland, *Schuster 22029b* (Schuster 1955c); Paradise Key, *Schuster 22586* (Schuster 1955); N of Homestead, Bauer Drive, Timms Hammock, *Schuster 33701e* (Schuster 1955); 3 mi off Collier Co. Line, along Rte. 94, *Schuster & Schuster 31741a, 31759a, 31761* (Schuster 1955). **Taylor Co.:** floodplain of Aucilla river N of US 98 at fish camp, on young *Taxodium* in patches, 5 May 1967, *Breil 1690* (NY); Breil (1970). **Wakulla Co.:** Breil (1970).

Cololejeunea ornata A. Evans

Alachua Co.: "Buzzard's Roost," 7–8 mi W of Gainesville, *Schuster 33348a pp* (Schuster 1980). **Citrus Co.:** Pineola, lime sinks, *Schuster 37224* (Schuster 1980). **Jackson Co.:** Chipola River, on xerophytic limestone cliff, 27 Mar 1927, *Kurz & Kennedy 145* (Evans 1938); 8 mi NW of Marianna, Dothan Highway, 5 Feb 1938, *Kurz 269* (Evans 1938); Breil (1970). **Without Co.:** Evans (1938); Frye & Clark (1947).

Cololejeunea setiloba A. Evans, Bryologist 16:51. 1913. Type: FLORIDA. Seminole Co.: Sanford, 10 May 1912, *Rapp 27*.

Columbia Co.: O'Leno State Park, near Santa Fe River, *Schuster 37289* (Schuster 1980). **Gadsden Co.** SR 268 at Little River floodplain, 4 mi W of Midway, on rotten log, 9 Mar 1967, *Breil 1581* (NY); Breil (1970). **Hardy Co.:** NE of Crewsville, *Schuster s.n.* (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, N edge, W of Sebring, *Schuster 44281e* (Schuster 1980). **Hillsborough Co.:** Hillsborough River State Park, Baynard Nature Trail, hardwoods in low-lying areas, on *Taxodium*, 4 Dec 1952, *Buck 22665* (NY). **Seminole Co.:** on bark of *Ilex glabra*, 10 May 1912, *Rapp 27* (NY); Sanford, on tree trunks, *Rapp 27, 59* (Haynes 1915, Frye & Clark 1947, Schuster 1980). **Wakulla Co.:** Breil (1970).

Cololejeunea sicaefolia (Gottsche) Pócs & Bern.-Lück.

Seminole Co.: Sanford, 1918, *Rapp 69* (Evans 1913, Frye & Clark 1947); Sanford, Nov 1917, *Rapp s.n.* (FLAS-B5335).

Cololejeunea sintenisii (Steph.) Pócs

Aphanolejeunea ephemeroides R.M. Schust., J. Elisha Mitchell Sci. Soc. 71:130. 1955. TYPE: FLORIDA. CLAY CO.: Gold Head Branch State Park, in ravine, over trunk of *Quercus laurifolia*, 31 Dec 1953, *Schuster & Schuster 31405* (*fide* Pócs & Lücking 1997).

Cololejeunea ephemeroides (R.M. Schust.) Stotler & Crand.-Stotl.

Clay Co.: Gold Head Branch State Park, in ravine, over trunk of *Quercus laurifolia*, 31 Dec 1953, *Schuster & Schuster 31407* (paratype of *A. verrucosa*, Schuster 1955). **Highlands Co.:** Highlands Hammock State park, on petiole base of *Sabal* palm, 10 Jan 1980, *Breil 5092* (NY). **Miami-Dade Co.:** Everglade Keys, Paradise Key, *Schuster 22590a* (paratype of *A. verrucosa*, Schuster 1955). **Seminole Co.:** Big Tree County Park, 3 mi N of Fern Park, *Schuster 42161, 42163* (Schuster 1980).

Cololejeunea subcristata A. Evans, Bryologist 20:24. 1917. TYPE: FLORIDA. MIAMI-DADE CO.: Hattie Bauer Hammock, on fronds of *Tectaria minima* [*T. fimbriata*], 18 Mar 1915, *Small & Mosier 5327* (HOLOTYPE: NY).

Hillsborough Co.: Hillsborough River State Park, rapids area, 21 Jan 1960, *Johnston 7A* (NY). **Miami-Dade Co.:** Hattie Bauer Hammock, Everglade keys, on fronds of *Tectaria minima* [*T. fimbriata*], 18 Mar 1915, *Small & Mossier 5327* (NY); on fronds of *Tectaria heracleifolia*, Costello Hammock near Silver Palm, 4 Feb 1939, *McFarlin 1742* (FLAS-B873); Nixon-Lewis Hammock, on leaves of *Trichomanes krausii*, 16 Mar 1915, *Small & Mosier 6008* (Evans 1917, Schuster 1980); Mar 1915, *McFarlin 1914* (Frye & Clark 1947).

Schuster (1980) reported this species based on a series of specimens from Miami-Dade Co. He considered it rare and in danger of extinction due to real estate developments. A further specimen from the Bahamas Archipelago (*Reese 11772*) is held at MO (not seen).

Diplasiolejeunea rudolphiana Steph.

Collier Co.: Ten Thousand Islands, *Swall 7553* (NY, Reyes 1982). **Hillsborough Co.:** *Keating 29* (NY, Reyes 1982); *Johnson 27* (NY, Reyes 1982). **Highlands Co.:** *Johnson 17* (NY, Reyes 1982). **Lake Co.:** Ocala National Forest, S of Astor Park, Alexander Springs (Schuster 1980). **Marion Co.:** Ocala National Forest, 3–4 mi below Juniper Springs (Schuster 1980). **Miami-Dade Co.:** Miami, Everglades, *Swall 5267* (NY, Reyes 1982). **Seminole Co.:** Sanford, on rotten trunks in swamp, 1917, *Rapp 68* (Haynes 1915, Frye & Clark 1947); *Rapp 682* (NY, Reyes 1982); Sanford, 1 Dec 1931, *Rapp s.n.* (FLAS-B7360); Sanford, Robinsons Springs, on young oak, Apr 1917, *Rapp s.n.* (FLAS-B6942).

Schuster (1980) stated that the report from Marion Co. is the northernmost station for the genus. He also provided additional records from counties cited above.

Drepanolejeunea mosenii (Steph.) Bischl.

Drepanolejeunea sabaliana R.M. Schust., J. Elisha Mitchell Sci. Soc. 83: 215. 1967. TYPE: FLORIDA. MARION CO.: Ocala National Forest, Juniper Springs, *Schuster 22093* (holotype: F, *fide* Reiner-Drehwald 1995a).

Clay Co.: Gold Head Branch State Park, in ravine, *Schuster 31461, 37203b* (Schuster 1980). **Marion Co.:** Ocala National Forest, Juniper Creek, 3–4 mi below Juniper Springs, *Schuster 33446d* (Schuster 1980); Juniper Springs, *Schuster 22093, 31913a, 31919, 31927, 31936a* (Schuster 1980).

Frullanoides bahamensis (A. Evans) van Slageren

Brachiolejeunea bahamensis A. Evans

Collier Co.: Everglades, 2–3 mi N of Tamiami Trail, between Ochopee and Monroe Station, on *Taxodium* in swamp, *Schuster 42094, 42096* (Schuster 1980). **Monroe Co.:** Big Pine Key, *Schuster 51748* (G, Gradstein 1994); *Schuster 42083* (S, Schuster 1980, Gradstein 1994). **Miami-Dade Co.:** Old Rhodes Key, Nov 1901, *Small & Nash 464* (Evans 1911a, 1911b); Madeira Bay, 1916, *Small 7557* (FH, NY, YU, Frye & Clark 1947, Gradstein 1994).

Frullanoides corticalis (Lehm. & Lindenb.) van Slageren

Brachiolejeunea corticalis (Lehm. & Lindenb.) Schiffn.

Lee Co.: Sanibel Island, Point Ybel, T46S, R23E, Sec. 21, on *Conocarpus erectus* in heavily disturbed coastal hammock, 22 Mar 1980, *Lassiter & Lassiter 490* (USF). **Miami-Dade Co.:** Everglades National Park, West Lake boardwalk, dense mixed mangroves to left of boardwalk entrance, on *Conocarpus erectus* at 3 ft. height, 8 Feb 1982, Lassiter & *Lassiter 597* (USF); Brickell Hammock south of Miami, 1904, *Britton 35* (Frye & Clark 1947); Brogdon Hammock, 1915, *Small & Mosier 6227* (Frye & Clark 1947). **Monroe Co.:** Everglades National Park, Wilderness Waterway, Tarpon Creek near Tarpon Bay, on *Rhizophora mangle*, 6 May 1983, Lassiter *& Lassiter 2237* (USF). **Palm Beach Co.:** Lake Worth, 1891, *Underwood 2178* (Frye & Clark 1947). **Seminole Co.:** Sanford, on trunk of live oak, *Rapp 38* (Haynes 1915).

Harpalejeunea molleri (Steph.) Grolle

Harpalejeunea ovata (Hook.) Schiffn. subsp. *integra* R.M. Schust., *fide* Grolle and Reiner-Drehwald (1999).

Liberty Co.: Apalachicola National Forest, near entrance to Camel Lake Recreation Area (Breil 1970, Schuster 1980); Johnson's Juniper Swamp, 8 mi S of Bristol (Schuster 1980).

Harpalejeunea stricta (Lindenb. & Gottsche) Steph.

Miami-Dade Co.: Everglades National Park, SW of outer tip of Long Pine Key, Mahogany Hammock, *Schuster 37321* (Schuster 1980).

Lejeunea adpressa Nees

Lejeunea caespitosa sensu Schuster, fide Thiers (in prep.).

Lejeunea longifissa Steph., Sp. Hepat. 5: 747. 1915, fide Schuster (1980).

Seminole Co.: Sanford, on bark of trees, 1917, *Rapp 83* (Evans 1918, Frye & Clark 1947); Sanford, on bark, Jul 1920, *Rapp s.n.* (FLAS-B6956).

Lejeunea aphanes Spruce

Lejeunea filipes Spruce, *fide* Schäfer-Verwimp & Reiner-Drehwald (2009).

Lejeunea autoica R.M. Schust., J. Hattori Bot. Lab. 25:6. 1962. TYPE: FLORIDA. HIGHLANDS CO.: Highlands Hammock State Park, W of Sebring, Highlands Hammock, 28 Dec 1959, *Schuster 44271* (*fide* Reiner-Drehwald 2000).

Citrus Co.: Pineola, limestone grottoes, *Schuster 37229* (Schuster 1980). **Highlands Co.:** The Type.

Reiner-Drehwald (2000) placed *L. autoica* under synonymy but did not examine the type.

Lejeunea bermudiana (A. Evans) R.M. Schust.

Crossotolejeunea bermudiana A. Evans

Lejeunea bermudiana ssp. *bermudiana*, fide Reiner-Drehwald & Goda (2000).

Lejeunea microgyna (R.M. Schust.) R.M. Schust., J. Hattori Bot. Lab. 72:274. 1992. Nom. Inval. Art. 36.1; *L. bermudiana* ssp. *microgyna* R.M. Schust., Hep. Anthoc. North. Amer. 4:1111. 1980. Nom. inval., Art. 36.1. Original material. USA. Florida: Lake Co., Alexander Springs, Schuster 31512 (fide Reiner-Drehwald & Goda 2000).

Alachua Co.: Green Sink, Gainesville, Dec 1932, *Little s.n.* (FLAS-B551). Devil's Millhopper NW of Gainesville, lime sink, *Schuster 33475, 33497a* (Schuster 1980); "Buzzard's Roost," 6 mi W of Gainesville, on damp coral limestone ledges, *Schuster 33349, 33359a, 33388a, 33414* (Schuster 1980). **Gadsden Co.:** Pronto Springs, ca. 22 mi N of Tallahassee, *Redfearn 1255* (Schuster 1980); Aspalaga Bluff on Apalachicola River, *Schuster 33332* (Schuster 1980); Breil (1970). **Jackson Co.:** Florida Caverns State Park, N of Marianna, *Schuster 44130a, 44131a, 44136* (Schuster 1980); Breil (1970). **Lake Co.:** Ocala National Forest, Alexander Springs, *Schuster 31410a, 31510a, 31512* (Schuster 1980). **Liberty Co.:** Torreya State Park, Rock Creek, *Schuster 44086, 44086a* (Schuster 1980). **Seminole Co.:** Sanford, Jun 1918, *Rapp s.n.* (FLAS-B7362),Sanford, Jun 1918, *Rapp s.n.* (FLAS); Sanford, on young tree in swamp, *Rapp 67* (Haynes 1915, Frye & Clark 1947, Reiner-Drehwald & Goda 2000);). **Taylor Co.:** E side of Aucilla River, along Rte. 98 E of Newport, on coral boulders, *Schuster s.n.* (Schuster 1980). **Washington Co.:** Breil (1970).

Reiner-Drehwald and Goda (2000) did not see the type as they put the species into synonymy. They assert however, that specimens need to be examined in order to confirm the existence of two different taxa.

Lejeunea calcicola R.M. Schust., J. Elisha Mitchell Sci. Soc. 73:404. 1957. TYPE: FLORIDA. GADSDEN CO.: near Apalachicola River, Aspalaga Bluff, over calcareous damp soil of bank and over *Dumortiera hirsuta*, *Schuster 33321*.

Alachua Co.: ca. 22 mi N of Tallahassee, "Buzzard's Roost," *Schuster 33348* (Schuster 1957, 1980). **Gadsden Co.:** ca. 7 mi W of Gainesville, Pronto Springs, *Redfearn 1255* (Schuster 1957, 1980); Florida Caverns State Park, near Chipola River, *Schuster 44150a* (Schuster 1980). **Jackson Co.:** caverns N of Marianna, 8 Nov 1937, *McFarlin 1397, 1399* (FLAS); Breil (1970). **Liberty Co.:** Torreya State Park, Rock Bluff on Apalachicola River, *Schuster 44031, 44032, 44033, 44039, 44081* (Schuster 1980); Breil (1970).

Originally described from Florida, this species has been reported also from Dale Co. in Alabama by Breil (1970) and Schuster (1980).

Lejeunea cancellata Nees & Mont.

Lejeunea cladiophora (R.M. Schust.) R.M. Schust.

Taxilejeunea cladiophora R.M. Schust., J. Elisha Mitchell Sci. Soc. 81:37. 1965. TYPE: FLORIDA. MIAMI-DADE CO.: NW of Homestead, W of Richard Road, N of Kings Highway, Redlands Hammock, 25 Dec 1958, *Schuster 42254*, *fide* Thiers (in prep.).

Collier Co.: N of Collier-Seminole State Park, 0.5–1.0 mi N of Tamiami Canal, low wet hammock forest (Royal Palm area), *Schuster 44366b* (Schuster 1980). **Miami-Dade Co.:** N of Homestead, Timms Hammock, Bauer Dr., on bark of *Elaphrium simaruba* [*Bursera simaruba*], 28 Dec 1951, *Schuster 22853* (Schuster 1980); Everglades National Park, *Schuster 19928a, 20151, 20158, 20175, 22857* (Schuster 1980); NW of Homestead, Redlands Hammock, *Schuster 42251* (Schuster 1980).

Lejeunea cladogyna A. Evans, Amer. J. Bot. 5:134. 1918. TYPE: FLORIDA. SEMINOLE CO.: Sanford, *Rapp 64* (US).

Alachua Co.: Mill Hopper, Gainesville, Dec1932, *Little s.n.* (FLAS-B563). Gainesville, 1916, *Nelson 104* (Evans 1918). **Calhoun Co.:** Breil (1970). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, R20E, T20S, Sec. 12, on decaying limb of large *Magnolia virginiana* in low hammock, 3 Apr 1980, Lassiter *et al.* 409 (USF). **Collier Co.:** Lake Trafford, *McFarlin & Grout 989*, (Frye & Clark 1947). **Columbia Co.:** O'Leno State Park, on Santa Fe River, N of High Springs (Schuster 1980). **Gadsden Co.:** Breil (1970). **Hernando Co.:** swamp 2–3 mi SE of Brooksville (Schuster 1980). **Highlands Co:** Lake Istokpoga, in hammock, 2 Aug 1937, *McFarlin 1348* (FLAS-B1921).Lake Istokpoga, in hammock, 2

Aug 1937, *McFarlin 1348* (FLAS); Sebring, 1934, *McFarlin 1200* (Frye & Clark 1947). **Hillsborough Co.:** near US 41, Bullfrog Creek, T30S, R19E, Sec. 26, on low bank of lime soil in intertidal area,13 May 1979, Merner S-4 (USF); Cockroach Bay Environmental Center, in mangrove, on *Quercus virginiana* (Te Strake et al. 1986). **Jefferson Co.:** Breil (1970). **Lee Co.:** Sanibel Island, T46S, R22E, Sec. 7, on *Eugenia axillaris* in tropical hammock, 22 Mar 1980, Lassiter & *Lassiter 350* (USF); Caloosahatchee, *Austin s.n.* (Evans 1918). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub, 1990–1992, *Amoroso 561* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Apalachicola River, Alum Bluff, Schuster 33471, 33532 (Schuster 1980). **Martin Co.:** in coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3589* (USF); hammock bordering Conor's Hwy, near Port Myacca, 24 Apr 1938, *McFarlin 1592* (FLAS). **Miami-Dade Co.:** Costello Hammock near Silver Palm, bark of trees, 4 Feb 1939, *McFarlin 1745* (FLAS); Everglades National Park, Royal Palm Hammock, just SE of Long Key pineland (Schuster 1980). **Polk Co.:** High Hammock near Fort Meade, on old log, 6 Jan 1939, *McFarlin 1732* (FLAS); Highlands Pool near Lakeland (Schuster 1980). **Putnam Co.:** 1 mi N of Orange Springs, Schuster 42210, 42211a, 42215 (Schuster 1980). **Taylor Co.:** Breil (1970). **Seminole Co.:** Sanford, on logs, *Rapp s.n.* (FLAS); Sanford, 1906–1913, *Rapp 6, 19, 64a, 64b, 69* (Evans 1918, Frye & Clark 1947). **Wakulla Co.:** Breil (1970).

Lejeunea deplanata Nees

Lejeunea maxonii (A. Evans) Xiao L. He

Rectolejeunea maxonii A. Evans, *fide* Reiner-Drehwald (2010).

Alachua Co.: Gainesville, Mar 1916, *Nelson 79, 92* (Evans 1918). **Bay Co.:** Breil (1970). **Jackson Co.:** Breil (1970). **Jefferson Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 685* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Apalachicola River, Alum Bluff, Schuster 33471, 33532 (Schuster 1980). **Martin Co.:** In coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3589* (USF); Hammock bordering Conor's Hwy, near Port Myacca, 24 Apr 1938, *McFarlin 1592* (FLAS-B887).Breil (1970). **Miami-Dade Co.:** Costello Hammock near Silver Palm, on bark of trees, 4 Feb 1939, *McFarlin 1748* (FLAS-B1736). **Polk Co.:** Highlands Pool near Lakeland (Schuster 1980); High Hammock near Fort Meade, on old log, 6 Jan 1939, *McFarlin 1732* (FLAS-B1923). **Putnam Co.:** 1 mi N of Orange Springs, Schuster 42210, 42211a, 42215 (Schuster 1980). **Taylor Co.:** *s.c., s.n.* (Breil 1970).). **Seminole Co.:** Sanford, 7 Oct 1930, *Rapp s.n.* (FLAS); Sanford, Robinson Spring 8 mi S of Sanford, Apr 1917, *Rapp 87* (Evans 1918, Frye & Clark 1947); Sanford, on logs, *Rapp s.n.* (FLAS-B5119). **Taylor Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Lejeunea flava (Sw.) Nees

Lejeunea americana A. Evans, *fide* Breil (1970) & Schuster (1980).

Alachua Co.: Rattlesnake Branch, Gainesville, 20 Jan 1933, *Little s.n.* (FLAS-B564). **Baker Co.:** Breil (1970). **Bay Co.:** Breil (1970). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, common in low hammock, 3 Apr 1980, Lassiter *et al. 341* (USF). **Collier Co.:** Naples 1934, *McFarlin & Grout 987* (Frye & Clark 1947). **Columbia Co.:** Breil (1970). **Dixie Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Gilchrist Co.:** Breil (1970). **Hamilton Co.:** Breil (1970). **Hernando Co.:** 2 mi W of Brooksville, T22S, R19E, Sec. 10, on rotting wood in low woods, 15 Nov 1980, Lassiter & *Lassiter 509* (USF). **Highlands Co.:** Highlands Hammock, Sebring, 1934, *McFarlin 1202* (Frye & Clark 1947). **Hillsborough Co.:** Hillsborough River, 2 mi E of Morris Bridge, T27S, R20E, Sec. 26, SE 1/4, on cypress in riverine swamp, 3 May 1980, *Lassiter & Crewz 454* (USF). **Holmes Co.:** Breil (1970). **Jackson Co.:** Breil (1970). **Jefferson Co.:** Breil (1970). **Lafayette Co.:** Breil (1970). **Leon Co.:** Lana Stein Hammock, 1939, *Schornherst 584* (Frye & Clark 1947); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in cypress dome, 1990–1992, *Amoroso 538, 555, 561, 1105* (FLAS, Amoroso & Judd 1995). **Manatee Co.:** Manatee, 20 Mar 1931, *McFarlin 399* (FLAS-B1926). **Martin Co.:** in coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3586* (USF). **Miami-Dade Co.:** Miami, on bark, Nov 1904, *Small 16* (USF); Key Largo, 1 Mar 1931, *McFarlin 523* (FLAS-B1954, 2804); Timm's); Timms Hammock near Silver Palm, 24 Feb 1940, *McFarlin 1968* (FLAS-B886, 1734). **Monroe Co.:** Everglades National Park, Wilderness Waterway: S of Cabbage Island, near Marker 28, at base of small, dead *Rhizophora mangle*, 7 May 1983, *Lassiter & Lassiter 725* (USF). **Polk Co.:** Lakeland, 29 Oct 1930, *McFarlin 35* (FLAS-B1929); Lake Rosalie, 8 Apr 1931, *McFarlin 552* (FLAS-B1927). **St. John Co.:** St. Augustine, 1924, *Haynes 2166* (Frye & Clark 1947); St. Augustine, roots of live oak, 14 Jan 1924, *Haynes 2166* (FLAS-B5446).**Seminole Co.:** Sanford, on tree, near base and on roots, *Rapp 18* (Haynes 1915, Frye & Clark 1947); Sanlando Springs, 1 Jan 1947, *Schallert 11166* (FLAS-B7836); Sanford, Dec 1913, *Rapp s.n.* (FLAS-B5188). **Suwannee Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Union Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Lejeunea floridana A. Evans, Mem. Torrey Bot. Club 32:185. 1905. TYPE: FLORIDA. MIAMI-DADE CO.: near Homestead Road, between Cutler and Longview Camp, 9–12 Nov 1903, *Small & Carter 1355* (HOLOTYPE: NY).

Alachua Co.: Kingsley's Lake, Gainesville, Feb1933, *Little s.n.* (FLAS-B565). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, R20E, T20S, Sec. 12, on soil in low hammock, 19 Jul 1981, Lassiter & *Lassiter 566* (USF). **Clay Co.:** Gold Head Branch State Park, *Schuster 37209, 37211, 37212a, 37213* (Schuster 1980). **Gadsden Co.:** Glen Julia, *Breen 2258* (Schuster 1980); Breil (1970). **Gilchrist Co.:** Breil (1970). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44285, 44275d* (Schuster 1980). **Hillsborough Co.:** Lithia Springs, 17 Mar 1969, *Merner s.n.* (USF). **Leon Co.:** Breil (1970). **Levy Co.:** Manatee Springs State Park, Suwannee River near Chiefland, *Schuster 44246* (Schuster 1980). **Liberty Co.:** Torreya State Park, Rock Creek, *Schuster 44086* (Schuster 1980). **Marion Co.:** Ocala, Scott's Springs, Jan 1891, *Hep. Americanae, Underwood & Cook 107* (distributed under *Kantia aquatica* Underw., see excluded and doubious taxa FLAS-B554). **Miami-Dade Co.:** The Type. **Polk Co.:** Scott Lake, 22 Jan 1931, *McFarlin 171* (FLAS-B889), Highlands Pool near Lakeland, Dec 1948, *Sharp s.n.* (Schuster 1980). **Seminole Co.:** Sanford, on palm logs in hammock, Mar 1912, *Rapp s.n.* (FLAS-B5134), logs in hammock, *Rapp 11* (Haynes 1915, Frye & Clark 1947, Schuster 1980). **Washington Co.:** Breil (1970).

Restricted to southern Florida, southern Alabama and the West Indies (Schuster 1980).

Lejeunea glaucescens Gottsche

Lejeunea glaucescens var. *obsoleta* R.M. Schust., J. Elisha Mitchell Sci. Soc. 73:395. 1957. TYPE: FLORIDA. MIAMI-DADE CO.: S of Coral Gables, Old Cutler Road, Mathesson Hammock, in deep hammock forest, on a decaying shaded log, 27 Dec 1954, *Schuster 33860*. *fide* Thiers (in prep.).

Collier Co.: Big Cypress Swamp, W of Deep Lake, 15 Apr 1934, *McFarlin & Grout 1038, 1060* (FLAS-B1917, 1918); Deer Lake in Collier County, 1934, *MacFarlin & Grout 1035* (Frye & Clark 1947). **Gadsden Co.:** Breil (1970). **Hillsborough Co.:** Tampa Bay, Big Cockroach Mound, S of Cockroach Bay Road, small amount at base of medium-sized *Zanthoxylum fagara*, at base of mound, 10 Jun 1983, Lassiter & *Lassiter 820* (USF). **Jackson Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 1098, 1099, 1100* (FLAS, Amoroso & Judd 1995). **Miami-Dade Co.:** Everglades National Park, E side of Long Pine Key, Paradise Key (Royal Palm Hammock), *Schuster 36812, 36822a* (Schuster 1980). **Seminole Co.:** Sanford, on logs, *Rapp 55* (Haynes 1915, Frye & Clark 1947); Sanford, on logs, Nov 1925, *Rapp s.n.* (FLAS-B6644).

Lejeunea laetevirens Nees & Mont.

Microlejeunea laetevirens (Nees and Mont.) A. Evans

Bay Co.: Breil (1970). **Clay Co.:** Gold Head Branch State Park, on old oak bark, 14 May 1982, Merner s.n. (USF). **Collier Co.:** ca. 4 mi SW of Monroe Station on "Loop Road," "Gator Hook slough," cypress swamp-pond-apple area and bordering gladeland, on fronds of *Trichomanes holopterum*, 5 Jun 1966, *Long et al. 1688c* (USF); Royal Palm Hammock, 14 Apr 1934, *Grout & McFarlin 1071a* (FLAS-B1976).); Royal Palm Hammock, 1934, *Grout & MacFarlin 1071a* (Frye & Clark 1947). **Columbia Co.:** Breil (1970). **Dixie Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Gilchrist Co.:** Breil (1970). **Highlands Co.:** Highland Hammock near Sebring, 1934, *MacFarlin 1001* (Frye & Clark 1947). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on large *Avicennia germinans* in coastal hammock, 2 Apr 1980, Lassiter *et al. 390* (USF); Cockroach Bay Environmental Center, in mangrove, on *Juniperus silicicola* [*J. virginiana*], *Quercus virginiana*, *Avicennia germinans* and *Conocarpus* (Te Strake et al. 1986). **Jackson Co.:** Caverns N of Marianna, 8 Nov 1937, *McFarlin 1410, 1409* (FLAS-B1984, 1985). **Jefferson Co.:** Breil (1970). **Lafayette Co.:** Breil (1970). **Lake Co.:** Alexander Springs, S of Astor Park (Schuster 1980). **Lee Co.:** Sanibel Island, Point Ybel, T46S, R23E, Sec. 21, on live *Avicennia germinans* in heavily disturbed coastal hammock, 22 Mar 1980, Lassiter & *Lassiter 349* (USF). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub, 1990–1992, *Amoroso 561, 684, 685, 937, 1099* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Breil (1970). **Manatee Co.:** Bishop's Harbor Road, 0.5 mi S of Bishop's Harbor, on *Quercus virginiana*, 26 Nov 1983, Lassiter & *Lassiter 781* (USF); Madira Bickel Mound, in mangrove, on dead oak (Te Strake et al. 1986); Myakka City, 21 Mar 1931, *McFarlin 458* (FLAS-B1975). **Marion Co.:** Ocala National Forest, Juniper Springs (Schuster 1980). **Miami-Dade Co.:** Timms Hammock, 1940, *MacFadden 7488* (Frye & Clark 1947). **Monroe Co.:** Everglades National Park, SR 27 and Rowdy Bend Road, on *Laguncularia racemosa* in mixed buttonwood and hardwood hammock, 7 Feb 1982, Lassiter & *Lassiter 596* (USF); Cape Sable, 1934, *MacFarlin 1346* (Frye & Clark 1947). **Orange Co.:** Rock Springs Park, 27 Jan 1947, *Schallert s.n.* (FLAS). **Pinellas Co.:** Maximo Park, Pinellas Point Dr., at base of large *Quercus virginiana*, on leeward side, 11 Dec 1982, Lassiter & *Lassiter 661* (USF). **Polk Co.:** Fort Meade, Peace River swamp, *s.c.*, *s.n.* (Schuster 1980); Kissenger Springs, 15 Oct 1930, *McFarlin 20* (FLAS-B1978). **Taylor Co.:** Breil (1970). **Seminole Co.:** between Sanford and Upsala, on bark, 28 Aug 1918, *Rapp s.n.* (FLAS); Sanford, on bark of various trees, *Rapp 15* (Haynes 1915). **Volusia Co.:** Orange City (Schuster 1980). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Schuster (1980) provided additional localities (without specimen citations) from the counties cited above.

Lejeunea minutiloba A. Evans

Alachua Co.: ca. 7 mi N of Gainesville, "Buzzards's Roost" (Schuster 1980). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, on decaying limb of large *Magnolia virginiana* in low hammock, 3 Apr 1980, Lassiter *et al. 407* (USF). **DeSoto Co.:** Bay Hammock, 5 mi N of Arcadia (Schuster 1980). **Hillsborough Co.:** Tampa Bay, Big Cockroach Mound, S of Cockroach Bay Road, on rotting wood in thin strand of mixed coastal vegetation at base of mound, 10 Jun 1983, Lassiter & *Lassiter 2051* (USF); Cockroach Bay Environmental Center, in mangrove, on *Juniperus silicicola* [*J. virginiana*] and rotten wood (Te Strake et al. 1986). **Miami-Dade Co.:** Miami, Vizcaya, small colony on large *Conocarpus erecta* in thin mixed mangrove fringe by gazebo and 100 feet from bay, 15 Mar 1984, Lassiter & *Lassiter 2164* (USF). **Monroe Co.:** Everglades National Park, Wilderness Waterway, S of Chokoloskee, the old homesite of the deceased hermit Darwin, at base of slender *Bursera simaruba* near water, 6 May 1983, Lassiter *et al. 844* (USF). **Seminole Co.:** Big Tree Park, 3 mi N of Fern Park, Schuster 42153, 42155, 42160c, 42184 (Schuster 1980).

Lejeunea minutiloba var. **heterogyna** R.M. Schust., J. Elisha Mitchell Sci. Soc. 73:425. 1957. TYPE: FLORIDA. MIAMI-DADE CO.: 5–6 mi W of Florida City, hammock on Loveland Road, 1951, *Schuster 22702*.

Miami-Dade Co.: Everglades National Park, Everglade Keys, Long Key pineland, hammock in Sect. 24, *Schuster 22023* (Schuster 1980).

Lejeunea obtusangula Spruce

Taxilejeunea erosifolia Steph., fide Schuster (1980).

Taxilejeunea obtusangula (Spruce) A. Evans, fide Thiers (in prep.).

Alachua Co.: Devil's Millhopper, moist limestone, 29 Apr 1972, *Buck s.n.* (NY); Devil's Millhopper, NW of Gainesville, *Schuster 33478, 33481, 33486, 33497* (Schuster 1980). **Collier Co.:** Big Cypress Swamp near Deep Lake, 1935, *McFarlin 992, 1173* (Frye & Clark 1947); *McFarlin & Grout 993, 994, 1045* (Frye & Clark 1947); N of Tamiami Canal, N of Collier-Seminole State Park, low wet hammock, in cypress-royal palm area, *Schuster 44391, 44379* (Schuster 1980). **Columbia Co.:** O'Leno State Park, Santa Fe River, *Schuster 32279* (Schuster 1980). **Hardee Co.:** Redfearn (1952). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, over bark, 26 Dec 1950, *Shuster 19939* (NY); Highlands Hammock State Park, W of Sebring, *Schuster 44283, 44279* (Schuster 1980); Highlands Hammock near Sebring, 1935, *McFarlin 1161, 1163, 1168* (Frye & Clark 1947). **Hillsborough Co.:** Hillsborough River State Park, rapids area, at base of large tree on bark, 21 Jan 1960, *Johnson 12A* (NY); Hillsborough River State Park, *Schuster s.n.* (Schuster 1980). **Lee Co.:** Redfearn (1952). **Miami-Dade Co.:** Key Largo (Frye & Clark 1947). **Orange Co.:** Redfearn (1952). **Polk Co.:** Nalcrest, W of the canal to the Lake, low pineland, on grapevine, 26 Mar 1989, *Wheeler s.n.* (NY); Nalcrest, Walter Heiler Development, ca. 150 ft. E of canal to lake, on sandy loam, in woods, 26 Feb 1989, *Wheeler s.n.* (NY). **Seminole Co.:** Big Tree County Park, ca. 3 mi N of Fern Park, on base of *Taxodium*, in deep hammock forest, 23 Dec 1958, *Schuster 42160* (NY, Schuster 1980); Big Tree County Park, on cabbage palmetto, 30 Aug 1941, *Breen 1899* (NY); Big Tree County Park, ca. 3 mi N of Fern Park, *Schuster 42187a, 42179, 42162* (Schuster 1980); Sanford, Lake Mini, on palmetto, Mar 1934, *Rapp s.n.* (FLAS-B6749 under *Cheilolejeunea clausa*, det. B. Thiers); Sanford, Nov 1920?, *Rapp s.n.* (FLAS-B6981); Robinson Spring 8 mi E of Sanford, on tree trunks near base, Dec 1913, *Rapp 70* (NY, Schuster 1980, Haynes 1915). **Wakulla Co.:** E side of St. Mark's River, S of Newport, just above tidewater, on *Magnolia glauca*, 13 Mar 1927, *Kurz 101* (NY, Schuster 1980); E side of Wakulla River, S of US 98, on floodplain, at base of *Taxodium*, 5 May 1967, *Breil 1681* (NY, Breil 1970, Schuster 1980). **Without Co.:** 1877, *Donnell Smith s.n.* (NY, Schuster 1980).

Lejeunea phyllobola Nees & Mont.

Cheilolejeunea phyllobola (Nees & Mont.) Schiffn.
Lejeunea brittoniae (A. Evans) Grolle
Rectolejeunea brittoniae A. Evans, fide Reiner-Drehwald (2000)
Rectolejeunea phyllobola (Nees & Mont.) A. Evans

Alachua Co.: Creek C, Gainesville, Dec 1932, *Little s.n.* (FLAS-B612). **Collier Co.:** along canal 2.5–3 mi N of Monroe Co. line, on Rte. 94, "Loop Road," on *Ficus aurea*, *Schuster 44594* (Schuster 1980). **Escambia Co.:** Pensacola, 1935, *Frye s.n.* (Frye & Clark 1947). **Gadsden Co.:** Apalachicola River, on Aspalaga Bluff, coral limestone ledges, *Schuster 33322* (Schuster 1980). **Highlands Co.:** in low hammock on Lake Istokpoga, 2 Aug 1937, *McFarlin 1356* (FLAS-B1969); Highlands Hammock, W of Sebring, *Schuster 44281* (Schuster 1980). **Lake Co.:** S of Astor Park, Alexander Springs, *Schuster 31511* (Schuster 1980). **Liberty Co.:** Torreya State Park, along Apalachicola River, rare (Breil 1970). **Miami-Dade Co.:** Bauer Drive, NW of Homestead, Timms Hammock, *Schuster 22856b, 33701c, 33701h* (Schuster 1980); Everglades National Park, Palma Vista Hammock, NW of Paradise Key, *Schuster 19901, 22784* (Schuster 1980). **Monroe Co.:** Big Pine Key, NW quadrant, *Schuster 76-500, 76-502* (Schuster 1980).**Seminole Co.:** Sanford, on bark and on exposed roots, *Rapp 63* (Haynes 1915, Frye & Clark 1947); Sanford, Jan 1935, *Rapp s.n.* (FLAS-B6782, under *Rectolejeunea*); Sanford, 17 Apr 1913, *Rapp s.n.* (FLAS-B5148).

Additional specimens from the counties cited were included by Schuster (1980) under *R. brittoniae*.

Lejeunea spiniloba Lindenb. & Gottsche

Rectolejeunea spiniloba (Lindenb. & Gottsche) R.M. Schust., *fide* Reiner-Drehwald (1999).
Stylolejeunea spiniloba (Lindenb. & Gottsche) A. Evans, *fide* Breil (1970).

Gadsden Co.: along Apalachicola River, Aspalaga Bluff, on smooth, moist, hard limestone (Schuster 1980). **Hardee Co.:** ca. 4 mi W of Ona, T34S, R23E, Sec. 26, NW 1/4 of SE 1/4, bay swamp, on leaves of *Encyclia tampensis*, 11 Nov 2003, Hansen 12934 (USF). **Hillsborough Co.:** Cowhouse Slough near Hillsborough River, T28S, R19E, Sec. 12, on *Carya aquatica* on slough banks, 30 Apr 1980, Lassiter & *Lassiter 403* (USF). **Jackson Co.:** Marianna, 1927, *Kurz 144* (Frye & Clark 1947); Breil (1970). **Lee Co.:** Orange River, near Alva (Schuster 1980). **Levy Co.:** Suwannee River, Manatee Springs State Park and Blue Springs, Withlacoochee River (Schuster 1980). **Madison Co.:** Blue Springs, 1927, *Kurz 175* (Frye & Clark 1947). **Seminole Co.:** Sanford, on cypress, 1913, *Rapp s.n.* (Haynes 1915, Frye & Clark 1947); Sanford, 1918, *Rapp 52* (Frye & Clark 1947); Sanford, Feb1916, *Rapp s.n.* (FLAS-B6982). **Polk Co.:** Pursegone Creek, N side of FL 60, 1.5 mi E of Hillsborough Co. line, on bark in low hammock, 26 Jan 1980, Lassiter & *Lassiter 296* (USF). **Seminole Co.:** Sanford, Feb1916, *Rapp s.n.* (FLAS); Sanford, on cypress, 1913, *Rapp s.n.* (Haynes 1915, Frye & Clark 1947); Sanford, 1918, *Rapp 52* (Frye & Clark 1947). **Taylor Co.:** Breil (1970). **Wakulla Co.:** Newport, 1927, *Kurz 102* (Frye & Clark 1947); Breil (1970).

Lejeunea trinitensis Lindenb.

Cheilolejeunea piliioba (Spruce) A. Evans.
Lejeunea pililoba Spruce
Rectolejeunea pililoba (Spruce) R.M. Schust.

Polk Co.: Fort Meade, 1916, *Jennings s.n.* (Schuster 1980). **Without Co.:** Indian River and Cedar Keys, *Austin s.n.* (NY, Schuster 1980).

Schuster (1980) considers that the above collection stations have been destroyed, but several collections exist after his publication (Thiers in prep.).

Leptolejeunea elliptica (Lehm. & Lindenb.) Schiffn.

Collier Co.: ca. 4 mi SW on Monroe Station on "Loop Road," "Gator Hook slough," cypress swamp-pond-apple area and bordering gladeland, on fronds of *Trichomanes holopterum*, 5 Jun 1966, *Long et al. 1688a* (USF-254990). **Hillsborough Co.:** Hillsborough River State Park, over base of leaf of *Serenoa repens*, *Schuster 33908* (Schuster 1980).**Miami-Dade Co.:** Royal Palm Hammock, 1916, *Small 7045* (Evans 1917, Frye & Clark 1947); Costello Hammock near Silver Palm, on fronds of *Dryopteris reptans*, 4 Feb 1939, *McFarlin 1741* (FLAS-B1695); Costello Hammock near Silver Palm, 2 Mar 1939, *McFarlin 1743* (FLAS-B8224).

Additional localities for Collier and Miami-Dade counties were provided by Schuster (1980).

Leucolejeunea clypeata (Schwein.) A. Evans

Bay Co.: Breil (1970). **Columbia Co.:** Lake City, 26 Dec 1894, *Straub s.n.* (FLAS-B561) *s.n.* (FLAS); O'Leno State Park, Santa Fe River, *Schuster 37286* (Schuster 1980), Breil (1970). **Escambia Co.:** Gull Point, Pensacola, 11 Jul 1937, *McFarlin 1459*, (FLAS-B1720). **Gadsden Co.:** Breil (1970). **Hernando Co.:** McKethan Park, T21S, R20E, Sec. 13, on *Magnolia* in mesic hammock, 16 Jan 1980, Lassiter *& Lassiter 290* (USF). **Holmes Co.:** in hammock along Holmes Creek, near Bonifay, 9 Nov 1937, *McFarlin 1503, 1504, 1509, 1514, 1518* (FLAS-B1708, 1704, 1707, 1706, 1705); Breil (1970). **Jackson Co.:** caverns north of Marianna, 8 Nov 1937, *McFarlin 1401*, (FLAS-B1710). **Jefferson Co.:** 1 mi W of Aucilla R., Rte. 98, *Schuster 44194* (Schuster 1980); Breil (1970). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 682* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** in ravine along SR 18 near Bristol, 10 Nov 1937, *McFarlin 1541, 1544, 1545, 1547, 1548* (FLAS-B1698,1724, 1723, 1721, 1702); Torreya State Park, 10 Nov 1937, *McFarlin 1479, 1481, 1487*, (FLAS-B1700, 1701, 1722); Johnson's Juniper Swamp ca. 8 mi S of Bristol, 9 Nov 1937, *McFarlin 1443, 1500* (FLAS-B1699, 1714); Alum Bluff, 10 Nov 1937, *McFarlin 1533* (FLAS-B1703), Breil (1970). **Okaloosa Co.:** Galliver, low hammock along stream, 7 Nov 1937, *McFarlin 1464, 1465, 1466, 1469* (FLAS-B1711, 1717, 1716, 1709). **Polk Co.:** 6 mi W of Lakeland, 7 Feb 1931, *McFarlin 333* (FLAS-B1697). **Wakulla Co.:** Breil (1970). **Walton Co.:** Argyle, 7 Nov 1937, *McFarlin 1523* (FLAS-B1713). **Without Co.:** Kurz & Little (1933); Frye & Clark (1947).

Grolle (1983a) related this species to the fossil *Leucolejeunea antiqua*, found in amber in the Dominican Republic. This species is apparently lacking in central to southern Florida (Schuster 1980).

Leucolejeunea conchifolia (A. Evans) A. Evans

Archilejeunea conchifolia A. Evans, Mem. Torrey Bot. Club 8:128. 1902. TYPE: FLORIDA. LAKE CO.: Orange Bend, *Underwood 60*.

Alachua Co.: 2 mi E of Gainesville, pine flatwoods, bark of tree, 19 Apr 1950, *Redfearn 187* (FLAS); Rattlesnake Branch, Gainesville, Jan 1933, *Little s.n.* (FLAS-B574). **Bay Co.:** Breil (1970). **Calhoun Co.:** Breil (1970). **Clay Co.:** Gold Head Branch State Park, on *Lyonia ferruginea* on upland trail of ravine, 14 May 1982, Merner 690 (USF). **Escambia Co.:** Gull Point, Pensacola, 7 Nov 1938, *McFarlin 1457*, (FLAS); Canoe Creek, 6 mi W of Century, 14 Sep 1957, *Ford 5591a* (FLAS-B8083); Pensacola, 1935, *Frye s.n.* (Frye & Clark 1947). **Gadsden Co.:** Breil (1970). **Hamilton Co.:** Breil (1970). **Hernando Co.:** McKethan Park, in rotting wood on ground in *Quercus laevis* woods, 8 Jan 1984, Lassiter *& Lassiter 785, 786* (USF). **Highlands Co.:** Highlands Hammock, Sebring, 1934, *McFarlin 767, 1055, 1131* (Frye & Clark 1947). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on *Quercus* sp., in open area bordering coastal hammock, 13 Aug 1982, Lassiter *& Lassiter 809* (USF); Cockroach Bay Environmental Center, in mangrove, on *Quercus virginiana* (Te Strake et al. 1986). **Jackson Co.:** Breil (1970). **Jefferson Co.:** 1 mi W of Aucilla R., Rte 98, *Schuster 44202c* (Schuster 1980); (Breil 1970). **Lake Co.:** Ocala National Forest, Alexander Springs, *Schuster 33316d, 33425b* (Schuster 1980). **Leon Co.:** Lena Stein Ravine, 1943, *Schornherst s.n.* (Schuster 1980). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in scrub, 1990–1992, *Amoroso 529, 801, 803, 805, 809* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Breil (1970). **Marion Co.:** Ocala National Forest, Juniper Springs, *Schuster 31910a, 31911, 31939b, 31912, 31938a* (Schuster 1980). **Palm Beach Co.:** S side of County Line Road, across from Jupiter Cemetery, NW 1/4 Sec. 25, T40S, R42E, at base of *Ceratiola ericoides* in *Pinus clausa* scrub, 26 Jul 1980, Lassiter *& Lassiter 465* (USF). **Putnam Co.:** 1 mi N of Orange Springs, *Schuster 42213c* (Schuster 1980). **Seminole Co.:** Sanford, on living trees, *Rapp 39* (Haynes 1915); Sanford, 1916, *Rapp s.n.* (Frye & Clark 1947); Sanford, May 1931, *Rapp s.n.* (FLAS-B6962) Sanford, Apr 1916, *Rapp s.n.* (FLAS-B6763). **Suwanee Co.:** on SR 129, 4 mi N of Branford, high oak hammock, on rotting wood on ground, 8 Apr 1983, Corrine Lawman 722 (USF). **Volusia Co.:** NW of Deland, Hwy 17, *Blomquist 9014* (Schuster 1980).

Not known outside North America (Thiers in prep.).

Leucolejeunea unciloba (Lindenb.) A. Evans.

Alachua Co.: Devil's Millhopper, tree trunk, 27 Feb1950, *Redfearn 134* (FLAS); Devil's Millhopper, *Magnolia* trunk, 27 Feb 1950, *Redfearn 147* (FLAS); bayhead 3 mi E of Gainesville, bark of *Magnolia*, 24 Apr 1950, *Redfearn 188, 191* (FLAS); bayhead 3 mi E of Gainesville, bark of tree, 24 Apr 1950, *Redfearn 191* (FLAS). **Calhoun Co.:** Breil (1970). **Columbia Co.:** O'Leno State Park, *Schuster 37286b, 37284b* (Schuster 1980). **Dixie Co.:** Breil (1970). **Escambia Co.:** in low lying hammock along the Escambia River, 7 Nov 1937, *McFarlin 1451* (FLAS-B1725). **Gadsden Co.:** Breil (1970). **Hernando Co.:** US 41 N of Brooksville, near Chinsegut Hill, Col. Robins Park, at base of *Pinus* sp. in pine and turkey oak woods, 19 Jan 1985, Lassiter *& Lassiter 2066* (USF). **Hillsborough Co.:** Alderman's Ford County Park, T30S, R22E, Sec. 19, on large *Viburnum obovatum* in low hammock near river, 14 Jun 1981, Lassiter *& Lassiter 361* (USF). **Holmes Co.:** Choctawhatchee River bridge at Hwy 2, bark of *Ilex* tree, 21 Aug 1957, *Ford 5349c* (FLAS); in hammock along Holmes Creek, near Bonifay, 9 Nov 1937, *McFarlin 1505* (FLAS-B1728). **Jefferson Co.:** Wacissa Springs, 1939, *Schornherst 304* (Frye & Clark 1947); Breil (1970). **Leon Co.:** Byrd's woods, 1939, *Schornherst 574* (Frye & Clark 1947); Breil (1970). **Levy Co.:** N of Gulf Hammock, *Schuster F-136* (Schuster 1980); Manatee Springs, Suwannee River near Chiefland, *Schuster 44225c, 44235c, 44245* (Schuster 1980. **Liberty Co.:** *s.c., s.n.* (Breil 1970); Alum Bluff, Apalachicola

River, *Schuster 33529b* (Schuster 1980). **Marion Co.:** Ocala National Forest, on rotting wood, 9 May 1980, Lassiter & *Thompson s.n.* (USF). **Miami-Dade Co.:** Timms Hammock near Silver Palm, on *Tectaria hieracifolia*, 28 Feb 1940, *McFarlin 1926* (FLAS-B7896); Johnson's Juniper swamp ca 8 mi S of Bristol, 9 Nov 1937, *McFarlin 1666* (FLAS-B1727). **Putnam Co.:** N of Orange Springs, *Schuster 42217a* (Schuster 1980). **Seminole Co.:** Sanford, on trees, *Rapp 41* (Haynes 1915, Frye & Clark 1947). **Union Co.:** *s.c., s.n.* (Breil 1970). **Walton Co.:** *s.c., s.n.* (Breil 1970).

Leucolejeunea xanthocarpa (Lehm. & Lindenb.) A. Evans

Miami-Dade Co.: Everglades, just SW of tip of Long Pine Key, 2.5 mi W of SW bend in Ingraham Hwy, *Schuster 37310a, 37313, 37332d pp* (Schuster 1980). **Seminole Co.:** Sanford, on bark of tree in hammock, *Rapp 49* (Evans 1914, Haynes 1915, Frye & Clark 1947, Schuster 1980); Sanford, on *Magnolia glauca*, 9 May 1914, *Rapp s.n.* (FLAS-B6268); Sanford, 26 Apr 1917, *Rapp s.n.* (FLAS-B6768).

Lopholejeunea nigricans (Lindenb.) Schiffn.

Lopholejeunea muelleriana (Gottsche) Schiffn.

Lopholejeunea muelleriana (Gottsche) Schiffn. subsp. *floridana* R.M. Schust., Hep. Anthoc. N. Amer. 4:751. 1980. TYPE: FLORIDA. PUTNAM CO.: Orange Springs, Schuster 42211 (ISOTYPE: C), fide Gradstein (1994).

Alachua Co.: Gainesville, Rattlesnake Branch, 20 Jan 1933, *Little s.n.* (FLAS-B577). **Collier Co.:** Lake Trafford, 21 Feb 1935, *McFarlin & Grout 989* (FLAS, Frye & Clark 1947); Big Cypress, 1935, *McFarlin 1001b* (Frye & Clark 1947). **Dixie Co.:** S of Old Town along the Suwannee River (Breil 1970); *Kurz 230* (Schuster 1980). **Highlands Co.:** in hammock on Lake Istokpoga, 2 Aug 1937, *McFarlin 13521* (FLAS-B1750); Sebring, 1934, *McFarlin 1173* (Frye & Clark 1947); Cape Sable, 1934, *McFarlin 1346* (Frye & Clark 1947). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, in swamp bordering W side of slough, on NW side of *Taxodium distichum*, 20 Dec 1980, Lassiter & *Lassiter 644* (USF). **Lake Co.:** Hontoon Island State Park, St. Johns River, *Schuster s.n.* (Schuster 1980). **Levy Co.:** Waccassasa Bay State Reserve, *Griffin II 171* (CANB, Zhu & Gradstein 2005), *Schuster F-120* (G, Gradstein 1994, Zhu & Gradstein 2005) **Marion Co.:** Silver Glen Springs, Ocala National Forest, *Schuster 42194* (Schuster 1980). **Miami-Dade Co.:** Costello Hammock near Silver Palm, *McFarlin 1574* (FLAS-B1688); Timms Hammock near Silver Palm, 24 Feb 1940, *McFarlin 1930* (FLAS-B1749). **Seminole Co.:** Sanford, on bark, *Rapp 40* (Haynes 1915, Frye & Clark 1947, Schuster 1980); Sanford, *Rapp s.n.* (NY, U, YU, Gradstein 1994.); Sanford, on trees, Oct 1910, *Rapp s.n.* (FLAS-B6269); Sanford, on trunk & roots, Feb 1917, *Rapp s.n.* (FLAS-B6765).

Lopholejeunea subfusca (Nees) Schiffn.

Lopholejeunea sagraeana (Mont.) Schiffn., *fide* Gradstein (1994).

Collier Co.: Big Cypress, 22 Jan 1935, *Grout & McFarlin 1001b, 1001a* (FLAS-B1742, B-1750); Royal Palm Hammock, 14 Apr 1934, *Grout & McFarlin 1071a* (FLAS-B1976). Loop Road, 3 mi S of Monroe Station, *Schuster 22037* (Schuster 1980). **Hernando Co.:** 3–4 mi NW of Brooksville, *Schuster 37150c, 37154* (Schuster 1980). **Highlands Co.:** Lake Istokpoga, in low hammock, 2 Aug 1937, *McFarlin 1358* (FLAS-B1752). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 33924* (Schuster 1980). **Marion Co.:** Oklawaha River, 4 mi E of Silver Springs, *Schuster 22504* (Schuster 1980). **Miami-Dade Co.:** Hattie Bauer Hammock near Modella, 28 Feb 1940, *McFarlin 1913* (FLAS-B1747); Timms Hammock near Silver Palm, 24 Feb 1940, *McFarlin 1964* (FLAS-B1754). **Monroe Co.:** Loop Road, 3 mi S of Monroe Sta., *Schuster 22037* (Schuster 1980). **Seminole Co.:** Sanford, Apr 1918, *Rapp s.n.* (U, Zhu & Gradstein 2005); Sanford, 1917, *Rapp 81* (Frye & Clark 1947, Schuster 1980); Sanford, Robinson's Springs, 10 Apr 1917, *Rapp s.n.* (FLAS-B6270), Jan 1932, *Rapp s.n.* (FLAS-B7166). **Without Co.:** 1877, *Donnell Smith s.n.* (Schuster 1980).

After Schuster (1980) the collection by Donnell Smith is the first collection from Florida.

Mastigolejeunea auriculata (Wilson & Hook.) Schiffn.

Alachua Co.: Gainesville, Rattlesnake Branch, *Little s.n.* (FLAS); Newnan's Lake, Gainesville, Nov 1933, *Little s.n.* (FLAS); Devil's Millhopper, oak trunk, 27 Feb 1950, *Redfearn 142* (FLAS). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, common on large *Quercus*, 3 Apr 1980, Lassiter *et al. 386* (USF). **Collier Co.:** Kissimmee Billie Swamp, in pop Ash swamp 20 mi E of Immokalee, 14 Apr 1938, *McFarlin 1554, 1562* (FLAS- B1784, B1776); Big Cypress Swamp, 22 Feb 1935, *McFarlin & Grout 996* (FLAS-1767); Big Cypress, 1935, *McFarlin 1001b* (Frye & Clark 1947). **Columbia Co.:** Lake City, 24 Dec 1894, *Straub s.n.* (FLAS-B560); (Breil 1970); Lake City, 27 Dec 1894, *Straub s.n.* (FLAS-B560), Breil (1970). **Gadsden Co.:** Crooked River, *Schornherst 664* (Schuster 1980); Breil (1970). **Gilchrist Co.:** Breil (1970). **Hernando Co.:** 2 mi N of Brooksville, T22S, R19E, Sec. 10, on *Quercus michauxii* on seepage slope in low hammock, 15 Nov 1980, Lassiter & *Lassiter 492* (USF). **Highlands Co.:** Hooker's Hammock, with *Lejeunea flava*, 5 Feb 1931, *McFarlin 313* (FLAS-B1956); Highlands Hammock State Park, *Griffin 987* (FLAS, NY, U, Gradstein 1994); *Thiers 3149, 3150* (NY, Gradstein 1994). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R19E, Sec. 28, on *Quercus* in coastal hammock, with large *Avicennia germinans*, 2 Apr 1980, Lassiter *et al. 408* (USF); Cockroach Bay Environmental Center, in mangrove, on *Conocarpus erectus* (Te Strake et al. 1986). **Holmes Co.:** along Holmes Creek near Bonifay, *McFarlin 1502* (FLAS-B1773); in hammock along Holmes Creek, near Bonifay, 9 Nov 1937, *McFarlin 1519* (FLAS-B1771). **Jackson Co.:** Caverns , 1937, *McFarlin 1409* (Frye & Clark 1947); Breil (1970); Caverns N of Mariana, 8 Nov 1937, *McFarlin 1408* (FLAS-1781). **Jefferson Co.:** Wacissa Springs, 1939, *Schornherst 304* (NY, Frye & Clark 1947, Schuster 1980, Gradstein 1994); Breil (1970). **Lee Co.:** near Naples, on cypress bark, 14 Apr 1934, *McFarlin & Grout 1045* (FLAS-B1764); Naples, 1934, *McFarlin & Grout 987* (Frye & Clark 1947, Schuster 1980). **Leon Co.:** Breil (1970). **Liberty Co.:** Rock Bluff, 10 Nov 1937, *McFarlin 1423* (FLAS-B1779); (Breil 1970); Johnson's Juniper

swamp ca. 8 mi S of Bristol, 9 Nov 1937, *McFarlin 1502* (FLAS-B1773), Breil (1970). **Levy Co.:** hammock just N of Gulf Hammock, *Schuster F-121, F-139, F-148* (Schuster 1980). **Marion Co.:** Marianna, Florida Caverns State Park, *Schuster 44134a* (Schuster 1980). **Miami-Dade Co.:** Costello Hammock near Silver Palm, 23 Apr 1938, *McFarlin 1580* (FLAS); Costello Hammock near Silver Palm, 23 Mar 1938, *McFarlin 1581* (FLAS); Key Largo, 9 Nov 1934, *McFarlin s.n.* (FLAS); Cuthbert Lake, 1916, *Small 7548* (Frye & Clark 1947). **Monroe Co.:** Everglades National Park, Buttonwood Canal near Flamingo, on *Piscidia piscipula* in coastal hammock along canal, 7 Feb 1982, Lassiter & *Lassiter 589B* (USF); Cape Sable region, in a buttonwood hammock ca. 2 mi N of Flamingo, 24 Feb 1940, *McFarlin 1903* (FLAS). **Okaloosa Co.:** near Galliver, along stream, 7 Nov 1937, *McFarlin 1462* (FLAS-B2080). **Polk Co.:** Pursegone Creek, N side of FL 60, 1.5 mi E of Hillsborough Co. line, on bark, 26 Jan 1980, Lassiter & *Lassiter 422* (USF); Lake Marion, 21 Jan 1931, *McFarlin 150* (FLAS-B1765). **Seminole Co.:** Sanford, on trunks in hammock, *Rapp 19* (Haynes 1915); Sanford, *Rapp s.n.*, *Verdoorn, Hep. Sel. Crit. 334* (BM, MANCH, NY, U, Gradstein 1994); Sanford, Melonville, on tree trunks, Nov 1917, *Rapp s.n.* (FLAS-B6770); Sanford, 29 Sep 1925, *Rapp s.n.* (FLAS-B7345). **Washington Co.:** Breil (1970).

Additional localities and specimen citations from some of the counties cited were given by Schuster (1980).

Microlejeunea bullata (Taylor) A. Evans

Microlejeunea ulicina (Taylor) A. Evans subsp. *bullata* (Taylor) R.M. Schust.

Baker Co.: Breil (1970). **Clay Co.:** Gold Head Branch State Park (Schuster 1980). **Collier Co.:** Collier-Seminole State Park and Royal Palm Hammock, N of Tamiami Trail (Schuster 1980). **Dixie Co.:** Breil (1970). **Hernando Co.:** 2 mi SE and 3–4 mi NW of Brooksville (Schuster 1980). **Highlands Co.:** Sebring, 1913, *Rapp s.n.* (Frye & Clark 1947); Tigers Branch in Highlands Hammock near Sebring, 1934, *McFarlin 1193* (Frye & Clark 1947); 45 mi S of Kissimmee (Schuster 1980). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, on *Campsis radicans* against large *Quercus* in low hammock, 24 Apr 1983, Lassiter & *Lassiter 703* (USF). **Lake Co.:** Ocala National Forest, Alexander Springs (Schuster 1980). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 538, 555, 679, 682, 684, 1098, 1100, 1108* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Alum Bluff, Apalachicola River (Schuster 1980); Breil (1970). **Manatee Co.:** Madira Bickel Mound, on crumbly, dead oak by steps, 26 Nov 1983, Lassiter & *Lassiter 818* (USF); Rattlesnake Key, in mangrove, on *Juniperus silicicola* [*J. virginiana*] (Te Strake et al. 1986); Madira Bickel Mound, in mangrove, on dead oak (Te Strake et al. 1986). **Marion Co.:** Ocala National Forest, Juniper Springs and Juniper Creek, 10 mi W of Juniper Springs (Schuster 1980). **Miami-Dade Co.:** Everglades National Park, Sect. 24 of Long Key pineland, Paradise Key (Royal Palm Hammock) (Schuster 1980); Mathesson Hammock; hammock on Loveland Road, ca. 1 mi N of Rte. 27, 5–6 mi W of Florida City; Costello Hammock, near Silver Palm (Schuster 1980). **Seminole Co.:** Sanford, on roots and on tree trunks, *Rapp 19* (Haynes 1915); Sanford, on maple, *Rapp s.n.* (FLAS-B6969); Big Tree County Park, 3 mi N of Fern Park and Sanford (Schuster 1980).

Microlejeunea epiphylla Bischl.

Lejeunea dimorphophylla R.M. Schust., Hep. Anthoc. N. Amer. 4:1080. 1980. TYPE: FLORIDA. HIGHLANDS CO.: Archbold Biological Station, 10 mi S of Lake Placid, *Schuster 44351c.*, *fide* Thiers (in prep.).

Collier Co.: Collier-Seminole State Park, mangrove swamp, *Schuster 76-398* (Schuster 1980). **Monroe Co.:** Big Pine Key, NW side, *Schuster 42087* (Schuster 1980).

Microlejeunea globosa (Spruce) Steph.

Lejeunea cardotii Steph., *fide* Reiner-Drehwald (1994b).

Highlands Co.: Archbold Biological Station, 10 mi S of Lake Placid (Schuster 1980). **Hillsborough Co.:** Cockroach Bay Environmental Center, T32S, R18E, Sec. 28, on *Laguncularia racemosa* in mixed mangrove strand along boardwalk, subject to tidal action, 18 Jul 1982, Lassiter & *Lassiter 847* (USF); S side of McMullen Branch of South Prong of Alafia River, ca. 2.6 mi E of SR 39, T31S, R22E, Sec. 16, on *Serenoa repens* leaves in mesic-hydric hardwood, 14 Jul 1980, *Shuey 714b* (USF-149583); Tampa, Horizon Park, Himes Ave. and Dale Mabry Hwy, at base of *Quercus* in dry woods, 5 Apr 1985, *Lassiter & Lassiter 2106* (USF-185024); Tampa, Lowry Park, Sligh Ave. and North Boulevard, on *Quercus*, 25 Aug 1981, *Lassiter & Lassiter 798* (USF-176483); Cockroach Bay Environmental Center, in mangrove, on *Juniperus silicicola* [*J. virginiana*], *Quercus virginiana*, *Avicennia germinans*, *Conocarpus erectus* and rotten and burned wood (Te Strake et al. 1986). **Lake Co.:** Hontoon Island State Park, W of DeLand, *Schuster s.n.* (Schuster 1980). **Polk Co.:** W of Bartow, orange grove (Schuster 1980). **Seminole Co.:** Altamonte Springs, on live tree in woods; Big Tree County Park, 3 mi N of Fern Park (Schuster 1980).

Reported from Florida and Louisiana by Schuster (1980). The Florida records bear no numbers. The author states that the species is distributed from coastal Louisiana to Mexico and has rare and disjunct occurrences in central Florida.

Neurolejeunea breutelii (Gottsche) A. Evans

Liberty Co.: Apalachicola National Forest, Camel Lake Recreation Area, on bark of dead hardwood (Breil 1970); in Johnson's Juniper Swamp about 8 miles S of Bristol, 9 Nov 1937, *McFarlin 1502, 1690, 1686* (FLAS-B1773, B1748, B-1744); Apalachicola National Forest, Camel Lake Recreation Area, *Nyssa* swamp, *Breil 2411* (Schuster 1980). **Okaloosa Co.:** Galliver, in low hammock along stream, 7 Nov 1937, *McFarlin 1467* (FLAS-B1751).

Rectolejeunea berteroana (Gottsche) A. Evans

Miami-Dade Co.: Everglades National Park, Royal Palm Hammock, *Schuster 22592* (Schuster 1980); Mahogany Hammock, SW of tip of Long Pine Key, *Schuster 37304, 37321a, 37323a, 37350* (Schuster 1980). **Palm Beach Co.:** Lake Worth, *Underwood* s.n. (NY, Schuster 1980).

LEPIDOZIACEAE

Bazzania trilobata (L.) Gray

Liberty Co.: Johnson's Juniper Swamp, 8 mi S of Bristol (Schuster 1969, Kurz & Little 1933); Frye & Clark (1946).

Kurzia setacea (Weber) Grolle

Microlepidozia setacea (Weber) Jørg.

Kurzia pauciflora (Dicks.) Grolle, fide Schuster (1969).

Polk Co.: Lakeland, mixed with *Cephalozia connivens* and *Odontoschisma sphagni*, 29 Oct 1930, *McFarlin 39* (FLAS, McFarlin 1940, Redfearn 1952).

According to Schuster (1969), this species is restricted to bogs and this report "is certainly based on an error." Grolle (1963) did not examine the original material of the species originally collected in Rübeland, Harz (Germany, Spicilegium Florae Goettingensis 155. 1778). Grolle (1963) stated though that the calcareous region of origin does not match the acidophyllous, bog ecology of the specimens later distributed and cited under this name by Müller (1914, 1956 cit. per Grolle 1963) and Frye & Clark (1946). He therefore considered *K. setacea* a doubious name. This was rejected by Schuster who adhered to the "status quo," *i.e.* the species concept expressed in his treatment (Schuster 1969). A specimen held at FLAS from sandy substrate (see above) wholly coincides with Schuster's description of *K. setacea*, and is a valid record for Florida.

Kurzia sylvatica (A. Evans) Grolle

Lepidozia sylvatica A. Evans

Microlepidozia sylvatica (A. Evans) Jørg.

Alachua Co.: 5 mi S of Gainesville, in a bog, *Little* s.n. (Kurz & Little 1933). **Baker Co.:** Breil (1970). **Clay Co.:** Kingsley Lake, *Little* s.n. (Kurz & Little 1933). **Jefferson Co.:** 4 mi SW of Flint Rock, *Kurz* s.n. (Kurz & Little 1933); 0.5 mi from Drifton, *Kurz* s.n. (Kurz & Little 1933). **Lake Co.:** Ocala National Forest, Alexander Springs, *Schuster 33302* (Schuster 1969); Alum Bluff, Apalachicola River, *Schuster 33528* (Schuster 1969). **Leon Co.:** Breil (1970). **Liberty Co.:** Breil (1970). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, Mar 1912, *Rapp* s.n. (FLAS-B6771); Sanford, Feb 1917, *Rapp* s.n. (FLAS-B6772); Sanford, on sandy banks, *Rapp 25* (Haynes 1915, Frye & Clark 1946); McFarlin (1940); Redfearn (1952); Schuster (1969). **Volusia Co.:** Enterprise (Evans 1904, Schuster 1969); Redfearn (1952). **Walton Co.:** Breil (1970).

There is a confusion concerning the characteristics and affinities between *Kurzia sylvatica* and *K. setacea* (Grolle 1963, Schuster 1969). Following Schuster (1969), this species grows on calcareous and acidophyllous rock substrates, but is absent from peatbogs.

Telaranea longifolia (Howe) Engel & Merr.

Telaranea nematodes sensu Schuster 1969, *fide* Engel & Merrill (2004)

Alachua Co.: bog 5 mi S of Gainesville, *Little* s.n. (Kurz & Little 1933). **Bay Co.:** Breil (1970). **Clay Co.:** Kingsley Lake, *Little* s.n. (Kurz & Little 1933). **Collier Co.:** McFarlin (1940); Redfearn (1952). **Gadsden Co.:** Midway, 1938, *Schornherst 84* (Schuster 1969, Frye & Clark 1946); Bristol, 1937, *McFarlin 1434* (Frye & Clark 1946); Bristol, *McFarlin* s.n. (Schuster 1969); Mossyhead, *McFarlin* s.n., (Schuster 1969). **Hernando Co.:** US 41 and SR 476, T21S, R20E, Sec.13, scattered among roots at base of large *Osmunda cinnamomea* in low hammock, 10 Apr 1980, Lassiter & Lassiter 368 (USF). **Highlands Co.:** W of Sebring, Highlands Hammock State Park, *Schuster 20099* (Schuster 1969); ditch side among *Callicostella pallid*, on wet soil, *Griffin 1709* (FLAS-B016622). **Hillsborough Co.:** S of Plant City, T29S, R22E, Sec. 25, English Creek, N of SR 60, on rotting wood in low woods, 5 May 1984, Lassiter *et al.* 837 (USF). **Jefferson Co.:** Breil (1970). **Leon Co.:** 4 mi from Tallahassee, on Old Spanish Trail, *Kurz* s.n. (Kurz & Little 1933); Breil (1970). **Manatee Co.:** McFarlin (1940); Redfearn (1952). **Marion Co.:** Juniper Springs, *Schuster* s.n. (Schuster 1969). **Seminole Co.:** Sanford, on sandy banks, *Rapp 22* (Haynes 1915, Frye & Clark 1946, Schuster 1969). McFarlin (1940); Redfearn (1952). **Taylor Co.:** Breil (1970). **Walton Co.:** Mossy Head, 1937, *McFarlin 1527* (Frye & Clark 1946); Breil (1970)

MARCHANTIACEAE

Marchantia paleacea Bertol.

Marchantia domingensis Lehm. & Lindenb., *fide* Bischler (1984, cit.per Schuster 1992b).

Alachua Co.: Devil's Millhopper, 6 mi NW of Gainesville, *Little* s.n. (Kurz & Little 1933). **Gadsden Co.:** Aspalaga, *Kurz* s.n. (Kurz & Little 1933); Aspalaga Bluff, on Apalachicola River, *Schuster 3309* (Schuster 1992b); Breil (1970). **Leon Co.:** Breil (1970). **Liberty Co.:** Torreya State

Park, near Rock Bluff, Apalachicola River, *Schuster 44032, 44033, 44039, 44075a, 44079a, 44080, 44081* (Schuster 1992b). **Taylor Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970). **Without Co.:** Kurz & Little (1933); Frye & Clark (1937).

Marchantia inflexa Nees & Mont.

Marchantia papillata Raddi subsp. inflexa (Nees & Mont.) R.M. Schust., *fide* Bischler-Causse *et al.* (2005).

Marchantia domingensis A. Evans; non Lehm. & Lindenb.

Alachua Co.: Devil's Millhopper, NW of Gainesville, *Harper 14* (Schuster 1992b); Devil's Millhopper, NW of Gainesville, *Griffin, s.n.* (Schuster 1992b); Devil's Millhopper, NW of Gainesville, *Schuster 33383, 33483* (Schuster 1992b). **Gadsden Co.:** Aspalaga Bluff, Apalachicola River, *Kurz 24* (Schuster 1992b); Breil (1970). **Hamilton Co.:** Suwannee River State park, *Schuster 97-071* (Schuster 1992b). **Leon Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Marchantia polymorpha L.

Leon Co.: 10 mi E from Tallahassee, *Kurz s.n.* (Kurz & Little 1933). **Seminole Co.:** Sanford, on ground and on bricks, *Rapp 7* (Haynes 1915, Frye & Clark 1937); McFarlin (1940); Redfearn (1952).

METZGERIACEAE

Metzgeria furcata (L.) Dumort.

Metzgeria ciliifera A. Evans, *fide* Grolle (2002, cit. per. Costa 2008).

Calhoun Co.: Breil (1970). **Gadsden Co.:** Breil (1970). **Hernando Co.:** McKethan Park, T21S, R20E, Sec. 13, on *Magnolia* in mesic hammock, 16 Jan 1980, Lassiter & *Lassiter 285* (USF). **Leon Co.:** Breil (1970). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, 1917, *Rapp s.n.* (Haynes 1915, Frye & Clark 1937); Redfearn (1952).

Highly gemmiparous forms of *Metzgeria furcata* and *M. myriopoda* are virtually impossible to distinguish morphologically (Fuselier et al. 2009). It is possible that true *M. furcata* does not occur in Florida.

Metzgeria myriopoda Lindb.

Alachua Co.: along run at the northern edge of Gainesville, *Little s.n.* (Kurz & Little 1933, Schuster 1992a); Devil's Millhopper, NW of Gainesville, *Schuster 33487* (Schuster 1992a). **Bay Co.:** Breil (1970). **Calhoun Co.:** Kuwahara (1986); Schuster (1992a). **Gadsden Co.:** Aspalaga Bluff, *Schuster 33330* (Schuster 1992a); Breil (1970). **Hernando Co.:** SE of Brooksville, *Schuster 22730* (Schuster 1992a). **Jackson Co.:** Florida Caverns State Park, near Marianna, *Schuster 44129a, 44134b* (Schuster 1992a); Breil (1970). **Leon Co.:** Tallahassee, 3 mi along Quincy Road, *Kurz s.n.* (Kurz & Little 1933); Lena Stein Ravine, *Schornherst 919* (Schuster 1992a). **Polk Co.:** Redfearn (1952); Schuster (1992a). **Seminole Co.:** Sanford, on *Magnolia* in high hammock and on exposed roots, *Rapp 29* (Haynes 1915); Sanford, Apr 1916, *Rapp s.n.* (Schuster 1992a). **Wakulla Co.:** Kuwahara (1986; Schuster (1992a); Breil (1970). **Washington Co.:** Breil (1970).

Metzgeria uncigera A. Evans

Gadsden Co.: Aspalaga, near Apalachicola River, in ravine on *Magnolia* tree, *Kurz & Little s.n.* (Kurz & Little 1933, Schuster 1992a). **Leon Co.:** Ochlockonee River floodplain along Florida Rte. 157 (Breil 1970). **Orange Co.:** Redfearn (1952). **Seminole Co.:** Sanford, on tree trunk, *Rapp 73* (Haynes 1915); Oviedo, *Rapp s.n.* (Kurz & Little 1933, Frye & Clark 1937); Robinson Spring, 8 mi S of Sanford, *Rapp s.n.* (Evans 1914, Schuster 1992a); Redfearn (1952). **Without Co.:** near Oneida, *Taylor 2114* (Costa 2008).

PALLAVICINIACEAE

Pallavicinia lyellii (Hook.) A. Gray

Baker Co.: Breil (1970); Schuster (1992a). **Bay Co.:** Breil (1970); Schuster (1992a). **Calhoun Co.:** Breil (1970; Schuster (1992a). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, in rotting stump in marshy border of hammock island, 3 Apr 1980, Lassiter *et al.* 383 (USF). **Clay Co.:** Gold Head Branch State Park, *Schuster 37208* (Schuster 1992a). **Columbia Co.:** Breil (1970); Schuster (1992a). **DeSoto Co.:** Redfearn (1952); Schuster (1992a). **Dixie Co.:** Breil (1970; Schuster (1992a). **Duval Co.:** Goodby's Lake, adjacent to St. Johns River, at base of uprooted tree on very moist soil bank, 2 Apr 1977, Grey 10 (USF). **Escambia Co.:** Pensacola, 1933, *Young s.n.* (Frye & Clark 1937); Pensacola, *Young, 1933* (Schuster 1992a). **Hernando Co.:** Croom Wildlife Management Area, Withlacoochee State Forest, bike trail, N side of Croom Road, 0.5 mi W of ranger station, app. 0.25 mi from road, on moist sand at edge of shallow waterway, 11 Aug 1995, *vanHoek et al.* 478 (USF). **Highlands Co.:** Highlands Hammock State Park, Leiser Memorial Trail, catwalk, moist soil at base of cypress tree, 4 Apr 1970, *Griepenburg s.n.* (USF); Highlands Hammock State Park, *Schuster F-102, 33789* (Schuster 1992a); McFarlin (1940); Redfearn (1952); Redfearn (1952); Schuster (1992a). **Hillsborough Co.:** USF Ecology Area, on soil in cypress community, 2 Apr 1974, Merner s.n. (USF). **Jefferson Co.:** Breil (1970); Schuster (1992a). **Leon Co.:** Owen's Wood, *Schornherst 2191* (Schuster 1992a); Breil (1970); Schuster (1992a). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, cypress dome, 1990–1992, *Amoroso 574, 935* (FLAS, Amoroso & Judd 1995). **Marion Co.:** Juniper Springs Creek, 1.3 mi downstream from Juniper springs, T15S, R26E, Sec. 16, SE of SW, low woods along creek bank, in full shade, 4 May 1979, Hansen & Richardson 5454 (USF); 3–4 mi below Juniper Springs, Ocala Natl. Forest, *Schuster 22462, 33466* (Schuster 1992a). **Martin Co.:** in coastal hammock, on rotting wood, 29 May 1980, *Sauleda et al.* 3572 (USF). **Orange Co.:** Rock

Springs Run, King's Landing, common on low bank of small sulphur pond, 23 May 1982, Lassiter *et al. 634* (USF). **Osceola Co.:** W side of US 17-192 at Poinciana Industrial Park, 0.7 mi N of Intercession City, 7 Apr 1980, *Richards s.n.* (USF). **Pasco Co.:** SR 54, 1.5 mi W of I-75, near Quail Hollow, on shaded stump in cut-over swamp, 27 Jan 1981, Lassiter *& Lassiter 498* (USF). **Pinelas Co.:** Mc Farlin (1940); Redfearn (1952); Schuster (1992a). **Polk Co.:** Redfearn (1952); Schuster (1992a). **Seminole Co.:** Sanford, on sandy banks and rotten stumps, *Rapp 10* (Haynes 1915); Sanford, 1920, *Rapp s.n.* (Frye & Clark 1937); *Rapp, 1920* (Schuster 1992a); Redfearn 1952, *fide* Schuster 1992a). **Taylor Co.:** Breil (1970); Schuster (1992a). **Union Co.:** Breil (1970); Schuster (1992a).

This species is very common on stumps and soil along streams throughout Florida (Kurz & Little 1933).

PLAGIOCHILACEAE

Plagiochila aspleniformis R.M. Schust., Amer. Midl. Naturalist 63:51. 1960. TYPE: FLORIDA. HILLSBOROUGH CO.: Hillsborough River State Park, *Schuster 22869.*

Columbia Co.: O'Leno State Park, 5 mi NW of High Springs, along the Santa Fe River; plants on limestone boulder, 20 Oct 1989, *Griffin 1001* (FLAS); O'Leno State Park, on the Santa Fe River, on sandy banks around the river sink (Breil 1970); O'Leno State Park, near border of Santa Fe River, N of High Springs, *Schuster 37276, 37276, 37276a* (Schuster 1980). **Hillsborough Co.:** Hillsborough Co., Hillsborough River State Park, *Schuster 22863, 22864* (Schuster 1980).

This species occurs in the "Oligocene I" region and is in danger of extermination due to overuse of park facilities (Schuster 1980).

Plagiochila floridana A. Evans, Bot. Gaz. 21:190. 1896. TYPE: FLORIDA. MARION CO.: Ocala, mixed with *Lejeunea* on decaying logs, *Underwood s.n. (Hep. Amer. 109,* HOLOTYPE: US).

Bay Co.: Breil (1970). **Citrus Co.:** 3 mi E of Floral City on Fowler's Island, T20S, R20E, Sec. 12, common on limestone outcrop, 3 Apr 1980, Lassiter *et al. 340* (USF). **Collier Co.:** Redfearn (1952). **Gadsden Co.:** Breil (1970). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster s.n.* (Schuster 1980). **Hillsborough Co.:** Hillsborough River State Park, N side of river at beach, next to trail, 12 Nov 1970, Griepenburg 10 (USF); *Schuster s.n.* (Schuster 1980). **Jackson Co.:** Marianna, 1934, *McFarlin 1393* (Frye & Clark 1945); Breil (1970). **Jefferson Co.:** 7 mi NE of Marianna, Balanced Rock, Chipola River floodplain margin, *Kurz s.n.* (Schuster 1980). **Lake Co.:** Ocala National Forest, Alexander Springs; below Juniper Springs, *Schuster s.n.* (Schuster 1980). **Liberty Co.:** Apalachicola River bluffs, 1939, *Schornherst 31x* (Frye & Clark 1945); Hardaway Tract, *Schornherst s.n.* (Schuster 1980); Torreya State Park, above Rock Creek, *Schuster 44098a* (Schuster 1980). **Miami-Dade Co.:** Redfearn (1952). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, on exposed roots, *Rapp 30* (Haynes 1915); Sanford, *Rapp s.n.* (Frye & Clark 1945); Sanford, *Rapp s.n.(Verdoorn Hep. Select. et Crit. 386)* (Schuster 1980); near Oviedo, *Rapp s.n.* (Schuster 1980); McFarlin (1940); Redfearn (1952). **Suwannee Co.:** Suwannee River, 1939, *Schornherst 604* (Frye & Clark 1945). **Wakulla Co.:** Breil (1970).

Plagiochila invisa (R.M. Schust.) R.M. Schust.

Plagiochila ludoviciana var. *invisa* R.M. Schust., Amer. Midl. Naturalist 63:101. 1960. TYPE: FLORIDA. CITRUS CO.: Pineola, on bark of *Sapindus*, 16 Dec 1948, *Sharp s.n.*

Jackson Co.: Florida Caverns State Park, near Chipola River, *Schuster 44130* (F), *44135* (Schuster 1980). **Jefferson Co.:** S of Wacissa, at headwaters of Wacissa River (Breil 1970).

Plagiochila micropteryx Gottsche

Plagiochila diffusa Steph., fide Inoue (1989).

Plagiochila smallii A. Evans, Bull. Torrey Bot. Club 32:180. 1905. TYPE: FLORIDA. MIAMI-DADE CO.: near the homestead trail, between Cutler and Longview Camp, in hammocks, Small & Carter 1411 (HOLOTYPE: NY).

Miami-Dade Co.: Miami, 1916, *Rachel Love 11* (Frye & Clark 1945); Hattie Bauer Hammock, 1915, *Small & Mosier 5707* (Frye & Clark 1945); Goodburn Hammock, 1915, *Small & Mosier 5240* (Frye & Clark 1945); Osteen Hammock, 3–4 miles NW of Paradise Key, *Schuster 44464* (Schuster 1980); Brickell Hammock, S of Miami (Schuster 1980); Costello Hammock near Silver Palm (Schuster 1980); Ross-Costello Hammock (Schuster 1980); Timms Hammock, N of Bauer Drive, near Homestead (Schuster 1980); between Coconut Grove and Cutler (Schuster 1980); Everglades near Camp Longwiew (Schuster 1980); Hattie Bauer, Brogdon, Nixon-Lewis, Horton, Cox, Goodburn and Sykes Hammocks (Schuster 1980); Redlands Hammock, NW of Homestead, *Schuster 44398* (Schuster 1980); Fuchs Hammock, N of Homestead, *Schuster 76-405, 76-411* (Schuster 1980); McFarlin (1940); Redfearn (1952). **Monroe Co.:** Big Pine Key, *Small et al. 3685b* (Schuster 1980).

Plagiochila miradorensis Gottsche

Gadsden Co.: Glen Julia (Schuster 1980); Breil (1970). **Hernando Co.:** 3–4 miles NW of Brooksville, hammock forest, *Schuster s.n.* (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44275c, 44271c* (Schuster 1980). **Jackson Co.:** Florida Caverns State Park, *Schuster 44128, 44129, 44138a* (Schuster 1980). **Jefferson Co.:** W of Aucilla Road on Rte. 98, *Schuster 44199* (Schuster 1980). **Leon Co.:** Breil (1970). **Levy Co.:** N of Gulf Hammock and Manatee State Parks, near Chiefland, *Schuster 44236* (Schuster 1980). **Liberty Co.:** Torreya State Park, *Schuster 44046* (Schuster 1980). **Marion Co.:** Juniper Springs Recreation Area, 31 Mar 1969, *Griffin s.n.*

(FLAS-B013735); Ocala National Forest, Juniper Springs (Schuster 1980). **Polk Co.:** below Bartow (Schuster 1980). **Seminole Co.:** Sanford (Schuster 1980). **Walton Co.:** Breil (1970).

Plagiochila montagnei Nees

Plagiochila hypnoides Lindenb., *fide* Heinrichs & Gradstein (2000).

Collier Co.: Collier-Seminole State Park, Deep Lake and Royal Palm Hammock (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, 6 mi W of Sebring (Schuster 1980). **Monroe Co.:** Cape Sable, Elliott's Key and *Paurotis* Hammock (Schuster 1980). **Miami-Dade Co.:** Ross Hammock, N of Homestead (Schuster 1980); Osteen Hammock, 3–4 mi NW of Paradise Key (Schuster 1980); Everglades National Park, Paradise Key and hammock forest, Sect 12 of Long Key pineland (Schuster 1980); E end of Long Pine Key, deep hammock forest (Schuster 1980); Everglades of W Miami-Dade Co., SW tip of Long Pine Key, deep Mahogany Hammock (Schuster 1980); Old Cutler Road, Mathesson Hammock (Schuster 1980); N of Homestead on Bauer Drive, Timms Hammock (Schuster 1980); Costello Hammock near Silver Palm (Schuster 1980); Arch Creek Prairie, Freeman Hammock (Schuster 1980); Nixon-Lewis Hammock (Schuster 1980); Palma Vista Hammock near Paradise Key (Schuster 1980); Brogdon Hammock (Schuster 1980); NW of Homestead, Kings Highway, Redlands Hammock (Schuster 1980); Everglades near Longview Camp; hammocks near the Homestead Trail (Schuster 1980); near Homestead Road, between Cutler and Longview Camp (Schuster 1980). **Seminole Co.:** Big Tree County Park, N of Fern Park, *Schuster 42178, 42179a* (Schuster 1980).

Plagiochila patula (Sw.) Lindenb.

Plagiochila dubia Lindenb. & Gottsche, *fide* Heinrichs *et al.* (2002).

Plagiochila dubia var. *integrifolia* R.M. Schust., Amer. Midl. Naturalist 63:35. 1960. TYPE: FLORIDA. HIGHLANDS CO.: Highlands Hammock State Park, near Sebring, *Schuster 26004*.

Alachua Co.: "Buzzards Roost" W of Gainesville and "Devil's Millhopper," *Schuster s.n.* (Schuster 1980); S of SR 26, ca. 7 mi W of Gainesville, limestone outcrop, 29 Jan 1969, *Griffin s.n.* (FLAS-B13737, det. J. Heinrichs).**Bay Co.:** Aspalaga Bluff, on Apalachicola River, *Schuster s.n.* (Schuster 1980); Breil (1970). **Calhoun Co.:** Breil (1970). **Columbia Co.:** Breil (1970). **Collier Co.:** Collier-Seminole State Park, *Schuster 26179a.* (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 19954b, 20106a, 26301, 26011a, 44271a* (Schuster 1980). **Gadsden Co.:** (Breil (1970). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster s.n.* (Schuster 1980). **Hillsborough Co.:** 2 mi E of Morris Bridge, T27S, R20E, Sec. 26, SE 1/4, on cypress in riverine swamp of Hillsborough River, 23 Feb 1980, Lassiter *309* (USF); Hillsborough River State Park, hammock forest, *Schuster s.n.* (Schuster 1980). **Jackson Co.:** Breil (1970). **Jefferson Co.:** Breil (1970). **Lake Co.:** Alexander Springs, hydric hammock, on trunk of *Magnolia virginiana*, 24 Apr 1981, *Griffin 661* (FLAS-B54075, det. J. Heinrichs). **Leon Co.:** Breil (1970). **Liberty Co.:** Alum Bluff, Apalachicola River and Torreya State Park, *Schuster s.n.* (Schuster 1980); Breil (1970). **Marion Co.:** Juniper Springs, Ocala National Forest, hammock forest, *Schuster s.n.* (Schuster 1980). **Miami-Dade Co.:** Everglades National Park, Long Key pineland, *Schuster s.n.* (Schuster 1980); Long Key Pineland, *Schuster 22050, 22097* (Schuster 1980). **Polk Co.:** Pursegone Creek, N side of FL 60, 1.5 mi E of Hillsborough Co. line, on bark in low hammock, 26 Jan 1980, Lassiter *& Lassiter 299* (USF). **Seminole Co.:** Collier-Seminole State Park, deep hammock forest, *Schuster s.n.* (Schuster 1980). **Suwannee Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Plagiochila raddiana Lindenb.

Plagiochila ludoviciana Sull., *fide* Heinrichs & Gradstein (2000).

Bay Co.: Breil (1970). **Citrus Co.:** Pineola, limestone grottoes, *Schuster 37229b* (Schuster 1980). **Collier Co.:** Collier-Seminole State Park, Royal Palm Hammock, *Schuster 44386, 44387* (Schuster 1980); Redfearn (1952). **Columbia Co.:** Lake City (Schuster 1980); Breil (1970). **Gadsden Co.:** Glen Julia (Schuster 1980); Breil (1970). **Gilchrist Co.:** Breil (1970). **Hernando Co.:** 2 mi SE of Brooksville, *Schuster s.n.* (Schuster 1980). **Highlands Co.:** Torreya State Park, 1934, *McFarlin 1484* (Frye & Clark 1945); Redfearn (1952). **Jackson Co.:** Florida Caverns State Park, near Chipola River, *Schuster 44134c* (Schuster 1980). **Jefferson Co.:** Alum Bluff, Apalachicola River, *Schuster s.n.* (Schuster 1980); Breil (1970). **Leon Co.:** Breil (1970). **Levy Co.:** Manatee Springs State Park, Suwannee River near Chiefland, *Schuster 44250* (Schuster 1980). **Liberty Co.:** Rock Bluff, 1934, *McFarlin 1446* (Frye & Clark 1945); Breil (1970). **Madison Co.:** Madison, 1934, *McFarlin 1034a* (Frye & Clark 1945). **Marion Co.:** Ocala, 1891, *Underwood & Cook 118* (Frye & Clark 1945); Ocala (Schuster 1980). **Miami-Dade Co.:** NW of Homestead, Redlands Hammock, *Schuster 42271d, 44409* (Schuster 1980); Timms Hammock, *Small & Mosier s.n.* (Schuster 1980); Hattie Bauer Hammock (Schuster 1980); Nixon-Lewis Hammock (Schuster 1980); Goodburn Hammock (Schuster 1980); Snapper Creek and Sykes Hammock (Schuster 1980); Mathesson Hammock, on Old Cutler Road, S of Coral Gables, *Schuster s.n.* (Schuster 1980); Redfearn (1952). **Polk Co.:** McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on trunks and exposed roots, *Rapp 31* (Haynes 1915); Sanford, 1933, *Rapp. s.n.* (Frye & Clark 1945); Redfearn (1952). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Plagiochila undata Sull.

Alachua Co.: Gainesville (Schuster 1980). **Citrus Co.:** Redfearn (1952). **Calhoun Co.:** Rock Park, Apalachicola R., Toprreya State Park (Schuster 1980). **Gadsden Co.:** Breil (1970). **Highlands Co.:** McFarlin (1940); Redfearn (1952). **Leon Co.:** Breil (1970). **Liberty Co.:** Alum Bluff, 1935, *Mcfarlin 1531* (Frye & Clark 1945). **Jackson Co.:** Breil (1970); Florida Caverns Sate Park near Chipola R. (Schuster 1980). **Orange Co.:** Sanford (Schuster 1980). **Polk Co.:** McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on exposed roots, *Rapp 14* (Haynes 1915); McFarlin (1940); Redfearn (1952). **Washington Co.:** Breil (1970).

PORELLACEAE

Porella pinnata L.

Baker Co.: Breil (1970). **Bay Co.:** Breil (1970). **Calhoun Co.:** Breil (1970). **Citrus Co.:** Floral City on Orange State Canal, at base of *Taxodium distichum*, 20 Apr 1979, Lassiter *& Lassiter 189* (USF); E shore of Lake Okeechobee, *Small 8418* (Schuster 1980); lime sink near Pineola, *Small 8946* (Schuster 1980). **Collier Co.:** Naples, 1934, *Grout & McFarlin 1034* (Frye & Clark 1946). **Columbia Co.:** Breil (1970). **DeSoto Co.:** Redfearn (1952). **Dixie Co.:** Breil (1970). **Franklin Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Hamilton Co.:** Breil (1970). **Hardee Co.:** McFarlin (1940); Redfearn (1952). **Hernando Co.:** US 98, near Brooksville, common on base of *Liquidambar styraciflua* at border of woods and drainage ditch, 30 Dec 1984, Lassiter *& Lassiter 2064* (USF). **Hillsborough Co.:** N side of Fowler Ave, near Morris Bridge, T28S, R19E, Sec. 13, on burned wood in low wooded area near Cowhouse Slough, 12 Sep 1981, Lassiter *& Lassiter 2064* (USF); Hillsborough River State Park, *Schuster s.n.* (Schuster 1980); Redfearn (1952). **Jackson Co.:** Chipola River, *Chapman s.n.* (Schuster 1980); Breil (1970). **Jefferson Co.:** W of Aucilla River on Rte. 98, *Schuster 44186a* (Schuster 1980). **Lee Co.:** McFarlin (1940); Redfearn (1952). **Leon Co.:** Breil (1970). **Levy Co.:** Manatee Springs State Park, Suwannee River near Chiefland, *Schuster 44230c, 44234* (Schuster 1980). **Liberty Co.:** Torreya State Park, Apalachicola River, *Schornherst 32* (Schuster 1980); Breil (1970). **Manatee Co.:** McFarlin (1940); Redfearn (1952). **Monroe Co.:** Key West, *Chapman s.n.* (Schuster 1980). **Pasco Co.:** Crystal Springs, in spring area, 15 Mar 1969, Latina s.n. (USF). **Polk Co.:** Pursegone Creek, N side of FL 60, 1.5 mi E of Hillsborough Co. line, on bark, 26 Jan 1980, Lassiter *& Lassiter 298, 421* (USF); McFarlin (1940); Redfearn (1952). **Seminole Co.:** Sanford, on tree trunk near base and on exposed roots, *Rapp 3* (Haynes 1915, Schuster 1980); Sanford, 1918, *Rapp s.n.* (Frye & Clark 1946); McFarlin (1940); Redfearn (1952). **Suwannee Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Washington Co.:** Breil (1970).

Porella platyphylla (L.) Lindb.

Porella platyphylloidea (Schwein.) Lindb., syn *fide* Therrien et al. (1998).

Porella platyphylla var. *platyphylloidea* (Schwein.) Frye & L. Clark, Hep. North Amer. 6: 723. 1946, *fide* Schuster (1980).

Jackson Co.: Florida Caverns State Park, *Schornherst 1334, 1510* (Schuster 1980); Marianna, Florida Caverns State Park (Breil 1970). **Liberty Co.:** Torreya State Park, along Apalachicola River (Breil 1970). **Without Co.:** Kurz & Little (1933); Frye & Clark (1946).

PTILIDIACEAE

Ptilidium pulcherrimum (Weber) Hampe

Collier Co.: Fakahatchee Strand State Preserve, off Tramway # 12., on cabbage palm, smooth trunk, Jan 1999, *Kelish s.n.* (NYS).

RADULACEAE

Radula australis Austin

Radula caloosiensis Austin, Bull. Torrey Bot. Club 6:301. 1879. TYPE: FLORIDA. LEE CO.: Caloosahatchee, 7 May 1878, *Donnell Smith & Austin s.n.* (HOLOTYPE: US).

Radula langloisii Castle, *fide* Breil (1970).

Bay Co.: Breil (1970). **Calhoun Co.:** Breil (1970). **Collier Co.:** Everglades National Park, Long Pine Key, on rim of solution hole in tropical hardwood hammock, 8 Feb 1982, Lassiter *& Lassiter 588A* (USF); Royal Palm Hammock, 1934, *Grout & MacFarlin s.n.* (Frye & Clark 1946); Deep Lake, 1934, *Grout & MacFarlin s.n.* (Frye & Clark 1946); Everglades along Rte. 94, 3 mi S of Collier Co. line, *Schuster 31748d* (Schuster 1980); Everglades 3 mi S of Monroe Station on Tamiami Canal, Rte. 94, *Schuster 37152a, 37158d, 37182a, 37183, 37184a* (Schuster 1980); McFarlin (1940); Redfearn 1952). **Dixie Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Hernando Co.:** US 41 and FL 476, T21S, R20E, Sec. 13, on *Magnolia* in low hammock, 20 Jan 1980, Lassiter *& Lassiter 307* (USF); 3–4 miles NW of Brooksville, *Schuster 22081a, 22085, 22110, 22110b* (Schuster 1980). **Highlands Co.:** Highlands Hammock State Park, *Schuster 33915a* (Schuster 1980); McFarlin (1940); Redfearn (1952). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, on *Taxodium distichum* in low hammock along slough, 8 Mar 1981, Lassiter *& Lassiter 514* (USF); Hillsborough River State Park, *Schuster 33915a* (Schuster 1980). **Jackson Co.:** Breil (1970). **Jefferson Co.:** Breil (1970). **Lee Co.:** McFarlin (1940); Redfearn (1952). **Leon Co.:** Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 685, 1099* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Alum Bluff, Apalachicola River, *Schuster 33531* (Schuster 1980); Breil (1970). **Madison Co.:** Madison, 1934, *MacFarlin 1034* (Frye & Clark 1946). **Marion Co.:** Juniper Springs, *Schuster 22464a, 31932c, 31945a* (Schuster 1980); Juniper Creek, ca. 4 mi below Juniper Springs, Ocala National Forest, *Schuster 33359a* (Schuster 1980). **Miami-Dade Co.:** ca. 3 mi W of Homestead, Fuchs Hammock, original hammock area mixed subtropical hardwoods, numerous sinkholes, on fronds of *Trichomanes krausii*, 26 Jun 1966, *Long et al. 1926b* (USF); Shield's Hammock, 1915, *Small et al. 6157* (Frye & Clark 1946); Horton Hammock, 1916, *Small 7010* (Frye & Clark 1946); Royal Palm Hammock, 1919, *Small et al. 9178* (Frye & Clark 1946); 1934, *Grout & McFarlin s.n.* (Frye & Clark 1946); 1935, *McFarlin 991* (Frye & Clark 1946); Everglades National Park, Mahogany Hammock, *Schuster 37369d* (Schuster 1980); McFarlin (1940); Redfearn (1952). **Pasco CO.:** Blanton, *Underwood 223* (Schuster 1980). **Monroe Co.:** McFarlin (1940); Redfearn (1952). **Saint Johns Co.:** 2 mi E of Hastings at junction of FL 206-207 at St. Johns River, at base of *Salix* trunk in *Taxodium*/red maple swamp, 8 Mar 1989, *Breil s.n.* (DUKE); St. Augustine, *Donnell Smith 1877* (Schuster 1980). **Seminole Co.:** Sanford, on trunks of tree in hammock palmetto, *Rapp 24* (Haynes 1915, Frye & Clark 1946); Sanford, 1904, 1915, *Rapp s.n*

(Schuster 1980); McFarlin (1940); Redfearn (1952). **Suwannee Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Wakulla Co.:** Breil (1970). **Without Co.:** Indian River, *Austin s.n.* (Schuster 1980).

Radula australis is restricted to outer coastal plain of SE United States, exceptionally occurring in the Apalachian Escarpment gorges (Schuster 1980).

Radula complanata (L.) Dumort.

Marion Co.: Juniper Creek, ca. 3–4 mi below springs, Ocala National Forest, *Schuster 33462* (NY). **Without Co.:** Evans & Nichols (1908); Frye & Clark (1946).

Schuster (1980) considered that this record based on sterile plants needs verification of the occurrence of paroecious specimens.

Radula flaccida Lindenb. & Gottsche

Collier Co.: Fakahatchee Strand State Preserve, along Janes Memorial Scenic Drive, ca. 2 mi NNW of Ranger Station, 4 Mar 2009, *Buck 54479* (NY). **Miami-Dade Co:** Hattie Bauer Hammock, 18 Mar 1915, *Small & Mosier 6005* (NY, Evans 1917, Frye & Clark 1946, Schuster 1980).

The reference cited by Frye & Clark is Graham 1933, a work from Surinam. This typical epiphyll seems now extinct in the area (Schuster 1980).

Radula javanica Gottsche

Radula floridana Castle, Rev. Bryol. Lichénol. 36:1. 1969. Type: FLORIDA. Miami-Dade Co.: Timms Hammock, 1915, *Small & Mosier s.n.* (holotype, NY), *fide* Yamada (1991).

Collier Co.: Collier-Seminole State Park, Royal Palm Hammock, *Schuster 20420b, 26142, 26179* (Schuster 1980). **Liberty Co.:** along Ochlockonee River, Forest Rd. 13, Apalachicola National Forest, on soil under trees along river in hardwood forest, 27 Dec 1990, *Breil 90-5820* (DUKE). **Miami-Dade Co.:** Redland Hammocks near Homestead, *Schuster 42129b, 42133, 42218a, 42271b, 44402* (Schuster 1980); Everglades National Park, Paradise Key, Royal Palm Hammock, *Schuster 19907, 19925, 20180* (Schuster 1980); Timms Hammock, N of Homestead, *Schuster 22856, 22857c* (Schuster 1980); Everglades National Park, Mahogany Hammock, SW of tip of Long Pine Key, *Schuster 37301b, 37328a, 37317, 37341, 37342c, 37352b* (Schuster 1980); Ross Costello Hammock, N of Homestead, *Schuster s.n.* (Schuster 1980). **Monroe Co.:** Florida Keys, *Small et al. 1524, 1526, 1535, 1548, 1554, 3663, 7819* (Schuster 1980). **Seminole Co.:** Sanford, *Rapp 4* (Castle 1925, Schuster 1980).

Schuster (1980) indicated that the type of *Radula floridana* is deposited in NY but it is not shown in the database.

Radula obconica Sull.

Liberty Co.: Apalachicola National Forest, Camel Lake Recreation Area, Camel Lake, Johnson's Juniper Swamp, in *Nyssa* swamp (Breil 1970, Schuster 1980). **Wakulla Co.:** S of Sopchoppy, Rte. 319, floodplain of Ochlockonee River River (Breil 1970, Schuster 1980).

Radula quadrata Gottsche

Radula mollis Lindenb. & Gottsche

Radula andicola Steph., *fide* Yamada (1993).

Liberty Co.: Torreya State Park, Rock Creek, *Schuster 44098* (Schuster 1980). **Jackson Co.:** Florida Caverns State Park, near Mariana, *Schuster 44136c* (Schuster 1980). **Miami-Dade Co.:** Ross Hammock, on *Ilex*, *Phillips 12* (Schuster 1980). **Wakulla Co.:** Wakulla Spring, *Kurz 152* (Schuster 1980); near Tallhassee, *Kurz 35c, 53, 105* (Schuster 1980).

Radula sullivantii Austin

Citrus Co.: 3 mi E of Floral City, T20S, R20E, Sec. 13, on limestone boulder in low hammock, 16 Jan 1980, Lassiter & *Lassiter 302* (USF). **Gadsden Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Liberty Co.:** Bristol, *McFarlin 1437* (Frye & Clark 1946); Breil (1970). **Madison Co.:** Breil (1970).

Schuster (1980) expressed considerable doubt that *R. sullivantii* occurs in Florida. He pointed out that it is easily confused with *R. floridana* (=*R. javanica*).

REBOULIACEAE

Reboulia hemisphaerica (L.) Raddi

Citrus Co.: Yulee Sugar Mill, near Homosassa, several patches on limestone walls of old, open, shallow curing pit, area rather dry, 20 May 1984, Lassiter *et al. 867* (USF). **Columbia Co.:** Breil (1970). **Escambia Co.:** Belleview, 1891, *Underwood & Cook s.n.* (Frye & Clark 1937).

Gadsden Co.: Aspalaga, *Kurz & Little s.n.* (Kurz & Little 1933). **Hamilton Co.:** Suwannee River State Park, *Schuster 87-068* (Schuster 1992b). **Leon Co.:** Tallahassee, ditch on college farm, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Liberty Co.:** Torreya State Park, *Schuster 44041, 44047* (Schuster 1992); Belleview, 1891, *Underwood & Cook s.n.* (Schuster 1992b). **Marion Co.:** Belleview, 1891, *Underwood & Cook s.n.* (Kurz & Little 1933, Frye & Clark 1937). **Nassau Co.:** Fort Clinch, Fernandina, *Schuster s.n.* (Schuster 1992b). **Seminole Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992b). **Suwannee Co.:** Breil (1970). **Taylor Co.:** Breil (1970). **Volusia Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992b).

RICCIACEAE

Riccia beyrichiana Hampe

Alachua Co.: Gainesville, at the Campus, *Little s.n.* (Kurz & Little 1933, Schuster 1992b); 3 mi W of Gainesville, pond, *Little s.n.* (Kurz & Little 1933). **Duval Co.:** Jacksonville, *Donnell Smith s.n.* (Evans 1912, Schuster 1992b). **Without Co.:** Frye & Clark (1937).

Riccia cavernosa Hoffm.

Collier Co.: Tamiami Canal, 8 mi E of Ochopee, *Schuster 37302* (Schuster 1992b). **Lee Co.:** near Corkscrew Sanctuary, *Schuster s.n.* (Schuster 1992b). **Manatee Co.:** Redfearn (1952); Schuster (1992b). **Polk Co.:** Redfearn (1952); Schuster (1992b). **Seminole Co.:** Sanford (Haynes 1915, Schuster 1992b); Redfearn (1952).

Riccia curtisii (Austin) Austin

Thallocarpus curtisii (Austin) Lindb.

Alachua Co.: Hatchet Creek, 8 mi E of Gainesville, *Little s.n.* (Kurz & Little 1933). **Highlands Co.:** McFarlin (1940); Redfearn (1952). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, common on open, recently flooded banks, 30 Jan 1980, Lassiter & *Lassiter 294* (USF). **Leon Co.:** Tallahassee, Silver Lake, 3 mi S from Tallahassee, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Orange Co.:** Haynes (1915). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, on rich soil in ditches, *Rapp 12* (Haynes 1915, Schuster 1992b); 1920, *Rapp s.n.* (Frye & Clark 1937); McFarlin (1940); Redfearn (1952). **St. Lucie or Martin Co.:** 12 mi E of Okeechobee City, hammock, *Britton & Britton 559* (NY). **Suwannee Co.:** Breil (1970).

After Schuster (1992b), the Tallahassee; James, Highlands, Polk and Seminole county records need revision.

Riccia fluitans L.

Citrus Co.: 3 mi E of Floral City, T20S, R20E, Sec. 13, common on open canal banks, 6 Mar 1980, Lassiter & *Lassiter 317* (USF); McFarlin (1940); Redfearn (1952); Schuster 1992b). **Collier Co.:** Big Cypress National Preserve, Roberts Lake Strand, T33E, R53N, Sec. 28, floating submersed in water 1 m deep in baseball-sized masses, 5 Mar 1978, *Avery et al. 1916* (USF); McFarlin (1940); Redfearn (1952); Schuster (1992b). **Gadsden Co.:** Breil (1970); Schuster (1992b). **Hardee Co.:** Redfearn (1952); Schuster (1992b). **Highlands Co.:** McFarlin (1940); Redfearn (1952). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, inside hollow cypress stump, 30 Dec 1980, Lassiter & *Lassiter 526* (USF). **Leon Co.:** Schuster (1992b). **Orange Co.:** Haynes (1915); Schuster (1992b). **Pasco Co.:** Cypress Creek Flood Detention Area and Well Field, W of I-75, T25S, R19E, Sec 14, floating in about 1.5 ft. of water, in center of cypress dome that has been augmented with water pumped from Floridan Aquifer, 28 Jun 1982, Rochow s.n. (USF). **Pinellas Co.:** Brooker Creek Park, scattered mats in sunny, quiet creek, 18 Sep 1983, Lassiter *et al. 720* (USF). **Polk Co.:** Redfearn (1952); Schuster (1992b). **Seminole Co.:** Sanford, in water and ditches, *Rapp 4* (Haynes 1915); 1911, *Rapp s.n.* (Frye & Clark 1937); McFarlin (1940); Redfearn (1952); Schuster (1992b). **Sumter Co.:** Withlacoochee River, Hog Island Recreation Area, Croom portion of the Withlacoochee State Forest, T21S, R21E, Sec 31, attached to limestone rocks with *Ricciocarpus natans* in oxbow, 31 Jan 1992, *vanHoek 235* (USF). **Taylor Co.:** Breil (1970); Schuster (1992b).

After Schuster (1992) Redfearn (1952) records belong to *R. stenophylla*. This species is common all over the region (Kurz & Little 1933).

Riccia gougetiana Durieu & Mont.

Riccia donnellii Austin, Bull. Torrey Bot. Club 6:157. 1877. TYPE: FLORIDA. DUVAL CO.: Jacksonville, in a garden, Feb 1877, *Donnell Smith s.n.* (holotype: US), *fide* Schuster (1992a).

Alachua Co.: pond, 3 mi W of Gainesville, *Little s.n.* (Kurz & Little 1933). **Duval Co.:** *Austin s.n.* (Frye & Clark 1937). **Hardee Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992b). **Highlands Co.:** Highlands Hammock State Park, *Schuster 44325* (Schuster 1992b). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, common on open, recently flooded banks, 30 Jan 1980, Lassiter & *Lassiter 288* (USF). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, on sand in ditches, *Rapp 9* (Haynes 1915); 1915, 1917, *Rapp s.n.* (Frye & Clark 1937); McFarlin (1940); Redfearn (1952); Schuster (1992b). **Without Co.:** Breil (1970).

Riccia hirta (Austin) Underw.

Gadsden Co.: Aspalaga Bluff, Apalachicola River, *Schuster 33328* (Schuster 1992b).

Riccia howei R.M. Schust., J. Hattori Bot. Lab. 71:271. 1992. TYPE: FLORIDA. COLLIER CO.: along Tamiami Canal, *Schuster 37303*.

Collier Co.: along Tamiami Canal, *Schuster 37303* (Schuster 1992). **Seminole Co.:** Sanford, *Rapp* s.n., 12 Apr 1911 (Haynes 1920, Schuster 1992a).

Plants presumably belonging here have been reported as *R. curtisii* from Leon and Suwannee Cos. by Breil (1970) *fide* Schuster (1992a). Distribution: Florida and Georgia.

Riccia huebeneriana Lindenb. subsp. **sullivantii** (Austin) R.M. Schust.

Riccia sullivantii Austin

Calhoun Co.: Breil (1970); Schuster (1992b). **Gadsden Co.:** Aspalaga Bluff, Apalachicola River, *Schuster 33327* (Schuster 1992b). **Leon Co.:** Tallahassee, Silver Lake, 3 mi S from Tallahassee, *Kurz* s.n. (Kurz & Little 1933); Breil (1970); Schuster (1992b). **Polk Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992b). **Seminole Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992b). **Without Co.:** Kurz & Little (1933); Frye & Clark (1937).

Riccia leptothallus R.M. Schust., J. Hattori Bot. Lab. 71:271. 1992. TYPE: FLORIDA: 1890–1891, *Underwood* s.n. (HOLOTYPE: FH).

Without Co.: *Underwood 2199* (Schuster 1992b).

Distribution: known only from Florida and Texas. This is closely related to *R. curtisii*, *R. howei*, and *R. compacta* (African) as discussed by Schuster (1992b).

Riccia membranacea Gottsche et. al.

Gadsden Co.: along Apalachicola River (Breil 1970); Aspalaga Bluff on Apalachicola River, *Schuster 33326* (Schuster 1992b). **Without Co.:** Bischler-Causse et al. (2005).

Riccia sorocarpa Bisch.

Leon Co.: Tallahassee, 3 mi along road to Quincy, *Kurz* s.n. (Kurz & Little 1933); Breil (1970); Schuster (1992b). **Without Co.:** Frye & Clark (1937).

Riccia stenophylla Spruce

Highlands Co.: Highlands Hammock State Park, *Schuster 83-2009* (Schuster 1992b). **Without Co.:** Bischler-Causse et al. (2005).

Ricciocarpos natans (L.) Corda

Riccia natans L.

Citrus Co.: 3 mi E of Floral City, T20S, R20E, Sec 13, common in water and stranded on open canal banks, 6 Mar 1980, Lassiter *& Lassiter 318* (USF). **DeSoto Co.:** ca. 2 mi S of the intersection of SR 72 and Pine Level Road, T38S, R23E, Sec 4, SE 1/4, floating in large, shallow marsh, in full sun, 1 Mar 1977, Shuey s.n. (USF). **Gadsden Co.:** Aspalaga Bluff, Apalachicola River, *Schuster 33329* (Schuster 1992b); Breil (1970). **Hernando Co.:** McKethan Park, near Brooksville, small plant floating along edge of marsh, 9 Jan 1982, Lassiter *& Lassiter 576* (USF). **Highlands Co.:** Highlands Hammock State Park, *Schuster* s.n. (Schuster 1992). **Hillsborough Co.:** Cypress Creek, above 30th St. Bridge, 28 Apr 1969, *Pardue* s.n. (USF). **Jackson Co.:** Breil (1970). **Jefferson Co.:** ca. 9 mi W of Capps, *Godfrey 54445* (Schuster 1992b); Breil (1970). **Leon Co.:** 3 mi W of Tallahassee, *Schornherst 2196* (Schuster 1992b); Breil (1970). **Liberty Co.:** Breil (1970). **Seminole Co.:** Sanford, side of ditch, *Rapp 8* (Haynes 1915); Sanford, *Rapp* s.n. (Schuster 1992b); McFarlin (1940); Redfearn (1952). **Sumter Co.:** Withlacoochee River, Hog Island Recreation Area, Croom portion of the Withlacoochee State Forest, T21S, R21E, Sec 31, attached to limestone rocks with *Riccia fluitans* in oxbow, 31 Jan 1992, *vanHoek 234* (USF). **Without Co.:** Frye & Clark (1937); Bischler-Causse et al. (2005).

This species is common in ponds in North Florida (Kurz & Little 1933).

SCAPANIACEAE

Scapania nemorea (L.) Dumort.

Bay Co.: Breil (1970). **Columbia Co.:** Breil (1970). **Gadsden Co.:** Breil (1970). **Hamilton Co.:** Breil (1970). **Leon Co.:** Breil (1970). **Liberty Co.:** Alum Bluff, 1939, *Schornherst 394* (Frye & Clark 1946); Torreya State Park, *Schuster* s.n. (Schuster 1974); Breil (1970). **Walton Co.:** Breil (1970). **Washington Co.:** Breil (1970).

SPHAEROCARPACEAE

Sphaerocarpos donnellii Austin, Bull. Torrey Bot. Club 6:157. 1877. TYPE: FLORIDA: in Gardens, Feb–Mar 1877, *Austin* s.n.

Alachua Co.: Payne's Prairie, 4 mi S of Gainesville, *Little* s.n. (Kurz & Little 1933). **Citrus Co.:** 3 mi E of Floral City, T20S, R20E, Sec 13, shaded bank of Orange State Canal, 17 Mar 1980, Lassiter 324 (USF); McFarlin (1940); Redfearn (1952). **Collier Co.:** Tamiami Canal near Ochopee, *Schuster 37301* (Schuster 1992a). **Duval Co.:** Jacksonville, 1877, *Donnell-Smith* s.n. (Kurz & Little 1933). **Hernando Co.:** 6 mi E of

Brooksville, growing on damp soil at the edge of a small lake on the N side of Rt. 50, 27 Jan 1960, Taylor & Taylor s.n. (USF). **Hillsborough Co.:** Cowhouse Slough, near Hillsborough River, T28S, R19E, Sec. 12, common on open banks, 3 Mar 1980, Lassiter & *Lassiter 357* (USF). **Leon Co.:** Tallahassee, Silver Lake, 3 mi S from Tallahassee, *Kurz s.n.* (Kurz & Little 1933); Breil (1970); Schuster (1992a). **Manatee Co.:** Myakka River State Park, along Myakka R., *Schuster 82-FAA1, 82-FAA2* (Schuster 1992a). **Polk Co.:** Redfearn (1952). **Seminole Co.:** Sanford, on sand in fields, *Rapp 17* (Haynes 1915); Sanford, 1912, *Rapp s.n.* (Frye & Clark 1937, Schuster 1992a); McFarlin (1940); Redfearn (1952).

Sphaerocarpos texanus Austin

Alachua Co.: Payne's Prairie, 4 mi S of Gainesville, *Little s.n.* (Kurz & Little 1933); 3 mi W of Gainesville, along pond, *Little s.n.* (Kurz & Little 1933). **Higlands Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Leon Co.:** Tallahassee, 3 mi along Quincy road, in corn field, *Kurz s.n.* (Kurz & Little 1933); Breil (1970); Schuster (1992a). **Manatee Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Seminole Co.:** Sanford, on walks, mixed with *Ricciella crystallina*, *Rapp 21* (Haynes 1915); Sanford, 1912, *Rapp s.n.* (Frye & Clark 1937, Schuster 1992a); McFarlin (1940); Redfearn (1952). **Taylor Co.:** Breil (1970); Schuster (1992a).

TRICHOCOLEACEAE

Trichocolea tomentella (Ehrh.) Dumort.

Gadsden Co.: *Kurz s.n.* (Schuster 1966); tributary of Flat Creek S of Bristol (Breil 1970).

ANTHOCEROTOPHYTA

ANTHOCEROTACEAE

Anthoceros agrestis Paton

Aspiromitus punctatus (L.) Schljakov subsp. *agrestis* (Paton) R.M. Schust. var. *agrestis* (Paton) R.M. Schust.

Alachua Co.: Gainesville (Schuster 1992b). **Seminole Co.:** Sanford, 1923, *Rapp s.n.* (Schuster 1992b). **Orange Co.:** Winter Park, 1924, *Haynes s.n.* (Schuster 1992b). **Hillsborough Co.:** Hillsborough River State Park, *Schuster 80-233* (Schuster 1992b).

Anthoceros punctatus L.

Alachua Co.: Gainesville, along creek S of Athletic Field, *Little s.n.* (Kurz & Little 1933). **Leon Co.:** Tallahassee, 3 mi towards Quincy along Rte. 1, *Kurz s.n.* (Kurz & Little 1933); Breil (1970). **Seminole Co.:** Sanford, on sandy bank, earth, and logs, *Rapp 47* (Haynes 1915).

Anthoceros scariosus Austin

Anthoceros punctatus var. *eatonii* Austin, Bull. Torrey Bot. Club 6:27. 1875. TYPE: FLORIDA: 1874, *Eaton s.n.*

Aspiromitus scariosus (Austin) R.M. Schust.

Phaeoceros carolinianus (Michx.) Prosk.

Anthoceros carolinianus Michx.

Anthoceros laevis L. subsp. *carolinianus* (Michx.) R.M. Schust.

Phaeoceros laevis (L.) Prosk. subsp. *carolinianus* (Michx.) Prosk., fide Breil (1970).

Phaeoceros donnellii (Austin) J. Haseg.

Anthoceros donnellii Austin, Bull. Torrey Bot. Club 6:304. 1879. TYPE: FLORIDA: SW Florida, banks of Caloosahatchee River, Mar 1878, Donnell Smith & Austin s.n. (HOLOTYPE: US), fide Hassel (1989).

Alachua Co.: Gainesville, along creek S of Athletic Field, *Little s.n.* (Kurz & Little 1933). **Calhoun Co.:** Breil (1970); Schuster (1992b). **Gadsden Co.:** Breil (1970); Schuster (1992b). **Hernando Co.:** 3–4 mi NW of Brooksville, *Schuster 22107* (Schuster 1992b). **Highlands Co.:** Highlands Hammock State Park, W of Sebring, *Schuster 44285* (Schuster 1992b). **Leon Co.:** Tallahassee, 3 mi towards Quincy along Rte. 1, *Kurz s.n.* (Kurz & Little 1933); Tallahassee, 1943, *Schornherst s.n.* (Breil 1970, Schuster 1992b); Breil (1970). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, in swamp, 1990–1992, *Amoroso 678* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** Rock Creek Park campground, Torreya State Park, *Schuster 44092* (Schuster 1992b). **Orange Co.:** 10 mi N of Apopka, *Conard 53-40* (Schuster 1992b). **Polk Co.:** 6 mi E of Haines City, *Conard s.n.* (Schuster 1992b). **Putnam Co.:** N of Orange Springs, *Schuster 42210* (Schuster 1992b). **Seminole Co.:** Sanford, on earth and logs, *Rapp 46* (Haynes 1915); Sanford, *Rapp s.n.* (Schuster 1992b). **Taylor Co.:** Breil (1970); Schuster (1992b).

Sphaerosporoceros adscendens (Lehm. & Lindenb.) Hässel

Anthoceros adscendens Lehm. & Lindenb.

Anthoceros olneyi Austin, Bull. Torrey Bot. Club 6:29. 1875. TYPE: FLORIDA: *Chapman s.n.* (HOLOTYPE: NY).

Aspiromitus adscendens (Lehm. & Lindenb.) R.M. Schust.

Duval Co.: Jacksonville, *Haynes 2151* (Schuster 1992b). **Franklin Co.:** Breil (1970); Schuster (1992b). **Hardee Co.:** side of stream, *Robinson s.n.* (Schuster 1992b); 10 Mar 1954, *Robinson s.n.* (Schuster 1992b). **Leon Co.:** Breil (1970); Schuster (1992b). **Seminole Co.:** Sanford, *Rapp 4, 82* (Schuster 1992b); Lake Harney, *Rapp s.n.* (Schuster 1992b). **Without Co.:** *Chapman s.n.* (Schuster 1992b).

NOTOTHYLADACEAE

Notothylas orbicularis (Schwein.) Sull.

Calhoun Co.: Breil (1970). **Gadsden Co.:** Breil (1970). **Leon Co.:** Apalachicola National Forest, Rocky Bluff Scenic Area, ca. 3 mi SW of Bloxham, seepy bank and floodplain of Ochlockonee River, 4 Dec 1988, *Buck 16702* (NY). **Wakulla Co.:** Breil (1970).

DUBIOUS AND EXCLUDED TAXA

Blassia pusilla L.

Gadsden Co.: Glen Julia, just S of Mount Pleasant, beech-*Magnolia* ravine (Breil 1970).

This report is based on a misidentification of *Aneura maxima*.

Calypogeia trichomanis (L.) Corda, *nomina rejicienda fide* Stotler and Crotz (1983).

Columbia Co.: Cedar Head Spring, near High Springs and Fort White, 4 Sep 1954, *Welch 20678* (NY). **Gadsden Co.:** Glen Julia, on moist soil, 25 Mar 1944, *Breen 2268* (NY). **Levy Co.:** Fanning Springs, submerged, attached to limestone, 8 Sep 1940, *Breen 854* (NY). **Marion Co.:** Ocala, Jan 1891, *Underwood 285* (NY). **Seminole Co.:** Sanford, Jan 1910, *Rapp 53* (NY); Sanford, on ditch bank, *Rapp 54* (Haynes 1915, Frye & Clark 1946); McFarlin (1940); Redfearn (1952).

In North America, the name *Calypogeia trichomanis* has been used by various authors to represent what is known today as *Calypogeia muelleriana* (Schiffner) K. Müller or *C. azurea* Stotler and Crotz. Given that *C. azurea* is a northern plant not known from the southeastern U.S., the reports below (as *C. trichomanis*) may well represent *C. muelleriana* but even that species is widely confused with *C. fissa*. Crum (1991, p. 63 & 64) stated "The actual separation of *C. fissa* from *C. muelleriana* is not clearly established" and *C. muelleriana* "is often impossible to differentiate from *C. fissa*."

Chiloscyphus coadunatus (Sw.) R.M. Schust & J.J. Engel

Lophocolea bidentata (L.) Dumort.

Gadsden Co.: Aspalaga Bluff along Apalachicola River (Breil 1970).

Not included from Florida by Schuster (1980), who considered reports from southern Alabama and Florida to be missidentificaitons of *Chiloscyphus apalachicolus*.

Chiloscyphus muricatus (Lehm.) J.J. Engel & R.M. Schust.

Lophocolea muricata (Lehm.) Nees

Reported by Frye and Clark (1943) based on reports by Stephani (1906–1909). Schuster (1980) excludes this taxon from Florida, claiming that there are no herbarium specimens available at G; he considered the occurrence of the species in Florida questionable. No specimens seen.

Cololejeunea biddlecomiae (Aust.) A. Evans

Reported from Miami-Dade County by Frye & Clark (1947). Schuster (1980) did not report the species from Florida and considered previous reports erroneous, based on misidentifications of *C. contractiloba* or *Aphanolejeunea tuberculata* (= *C. clavatopapillata*). He also stated that in the area it is replaced by *C. ornata* and *C. contractiloba*. No specimens seen.

Frullania dilatata (L.) Dumort.

Only one specimen known from Florida (Jefferson Co.: Monticello, on bark of trees, 4 Feb 1890, *s.c.* 39 [ex Underwood herbarium] (NY). Other specimens all from northeastern states collected in the late 1880's. Schuster (1992a) considered this to be a strictly European species closely related to *F. appalachiana* and *F. eboracensis*, but further study of the complex is needed. No specimens seen.

Frulliana kunzei var. **maritima** R.M. Schust., J Hattori Bot. Lab. 70:145. 1991. Type: FLORIDA. Collier Co.: Collier-Seminole State Park, in mature mangrove swamp forest, on bark of *Laguncularia*, *Schuster 76-390*. *Nom. Inval.* (herbarium not specified).

Frullania plana Sull.
Collier Co.: 1935, *McFarlin 991* (Evans & Nichols 1908, Frye & Clark 1947).

Schuster (1992a) considered all references to this species in Florida as erroneous.

Frullania riparia Hampe ex Lehm.

Reported from Florida by Redfearn (1952), but needs verification (Schuster 1992a). No specimens seen.

Frullania tamarisci (L.) Dumort.
Frullania asagrayana Mont., *fide* Schuster (1992a).
Collier Co.: 1935, *McFarlin & Grout 997* (Frye & Clark 1947). **Without Co.:** Jan–Apr 1891, *Underwood 2501a* (NY).

We follow Schuster (1992a) in concluding that *Frullania tamarisci* and *F. tamarisci subsp. asagrayana* do not occur in Florida.

Frullania tamarisci subsp. **asagrayana** (Mont.) S.Hatt.
Frullania asagrayana Mont.

"Confined to eastern North America, from (?) Baffin I. (p. 57) and northern Newfoundland southward to ?Florida (Hattori, 1972a, p. 232), westward to Ontario, Minnesota, Oklahoma, and Arkansas. Westward to the Ozark Mts. of Missouri" (Schuster 1992a). He further states "I have never seen the plant as far south as northern Florida and Breil (1970) also fails to report it from there; it seems absent in the entire region of the Coastal Plain, except in Va.-North Carolina, from South Carolina to Louisiana." No specimens seen.

Kantia aquatica Underw, *Hep. Americanae 107*. Original Material. USA. Florida: Marion Co., Ocala Scott's Springs, submerged 2–3 feet under water, Jan 1891, *Underwood & Cook 107* (FLAS!, US).

The material distributed under this name deposited in FLAS, belongs to *Lejeunea floridana* A. Evans. The genus *Kantia* is a synonym of *Calypogeia* (Grolle 1983b).

Lejeunea cavifolia (Ehrh.) Lindb.

According to Schuster (1980) the reports from Florida by Frye and Clark (1947) are misidentifications of *L. flava*. Reports by Redfearn (1952) also are misidentifications (Schuster 1980). No specimens seen.

Metzgeria conjugata Lindb.
Without Co.: Mohr (1901); Frye & Clark (1937).

We accept Schuster's opinion (Schuster 1992a) that the Florida reports above are based on old misdeterminations.

Microlejeunea ruthii A. Evans
Lejeunea ruthii (A. Evans) R.M. Schust., *fide* Thiers in prep.

Reported from Florida by Schuster (1962), but later (1980) said to have been in error and confused with *Lejeunea autoica* (See *Lejeunea filipes*).

Odontoschisma sphagni (Dicks.) Dumort.

Reported from Florida by Mohr (1901) and Frye and Clark (1945) based on a misidentification of *O. prostratum*.

Phaeoceros laevis (L.) Prosk.

Reported from Florida by Kurz & Little (1933) and Schuster (1992b). Stotler and Crandall-Stotler (2005) exclude this species from North America, considering the name misapplied to *P. carolinianus*, *P. mohrii* or *P. oreganus*. No specimens seen.

Plagiochila sullivantii Gottsche
Escambia Co.: Pensacola, 1935, *Frye s.n.* (Frye & Clark 1945). **Miami-Dade Co.:** Timms Hammock near Homestead, *McFarlin & Grout 1967* (Frye & Clark 1945); McFarlin (1940); Redfearn (1952). **Monroe Co.:** Key Largo, 1934, *McFarlin s.n.* (Frye & Clark 1945).

Schuster (1959, 1980) clearly establishes *P. sullivantii* as a southern Applalachian endemic with reports from Florida (and elsewhere) representing "gross errors in determination" or "mere compilations of the erroneous literature."

Reboulia hemisphaerica subsp. **sabalina** R.M. Schust., Hep. Anthoc. North Amer. 6:173. 1992, nom. nud.

Schuster fails to provide a Latin diagnosis and states "*Reboulia hemispherica* subsp. *sabaliana* R.M. Schust., J. Hattori Bot. Lab. 72, 1992 [in press]." No publication of the name was found in The Journal of the Hattori Botanical Laboratory. Known only from the specimen cited as "type": FLORIDA. Hamilton Co.: Suwannee River State Park, *Schuster 87-068*. Plants are best refered to *Reboulia hemispherica sensu lato.*

Rectolejeunea evansiana R.M. Schust. Hep. Anthoc. N. Amer. 4:1127. 1980; *nom. nud.*

Schuster (1980) cites two collections (Florida. Collier Co.: Collier-Seminole State Park, 19–21 Dec 1950, *Schuster 2037, 2037a*) and does not designate one as the type as required by the ICBN. The specimens cited by Schuster have not been seen by us, so we are hesitant to validate the name by publishing a holotype selection.

Additional specimens: **Collier Co.:** Collier-Seminole State Park, Schuster *26120* (Schuster 1980); Everglades, 3 mi S of Monroe Station on Loop Road, on bark of *Fraxinus carolinianus, Schuster 37158* (Schuster 1980). **Monroe Co.:** Everglades National Park, on base of *Laguncularia racemosa* in mixed buttonwood and hardwood hammock, 7 Feb 1982, Lassiter & *Lassiter 595* (USF).

Riccia canaliculata Hoffm.

Schuster (1992b) cites "Ochlochonee R., Wakulla Co. (Breil, 1970); archegonia; questionable" and later on same page says "Apparently absent east of the Mississippi R., except for the Michigan Report." No specimens seen.

Riccia crystallina L.

Reported from Florida by numerous authors (i.e., Kurz & Little 1933; McFarlin 1940; Redfearn 1952; Frye & Clark 1937; Haynes 1915) based on misidentifications of *Riccia cavernosa. Riccia crystallina* is not known to occur in North America (See also Schuster 1992b).

Riccardia latifrons Lindb.

Alachua Co.: Devil's Millhopper, 6 mi NW of Gainesville, *Little s.n.* (Kurz & Little 1933, Frye & Clark 1937). **Calhoun Co.:** Breil (1970); Schuster (1992a). **Citrus Co.:** Redfearn (1952); Schuster (1992a). **Columbia Co.:** Breil (1970); Schuster (1992a). **Dixie Co.:** Breil (1970); Schuster (1992a). **Gadsden Co.:** Chattahoochee, ravine, *Kurz s.n.* (Kurz & Little 1933); Breil (1970); Schuster (1992a). **Hernando Co.:** Chassahowitzka River, low hammock bordering spring, on needle palm trunk, 20 Jan 1980, Lassiter & *Lassiter 291* (USF). **Hillsborough Co.:** Hillsborough River between Fowler and Fletcher Aves., on base of *Sabal palmetto*, 19 Mar 1983, Lassiter & *Lassiter 696* (USF). **Martin Co.:** in coastal hammock on rotting wood, 29 May 1980, *Sauleda et al. 3583* (USF). **Leon Co.:** Breil (1970); Schuster (1992a). **Levy Co.:** N of Cedar Key, along State Road 24, Cedar Key Scrub Reserve, flatwoods, 1990–1992, *Amoroso 835, 935, 1109* (FLAS, Amoroso & Judd 1995). **Liberty Co.:** SR 20 near Hosford, few plants noted on *Sphagnum magellanicum* in small, shrubby, sandy depression wet from seepage of adjacent pineland, 1 Sep 1984, *Lassiter et al. 2022* (USF). **Seminole Co.:** McFarlin (1940); Redfearn (1952); Schuster (1992a). **Wakulla Co.:** Breil (1970); Schuster (1992a).

After 25 years of floristic field work in U.S., P.G. Davison has been unable to locate this species in the southeastern U.S. We accept Schuster's (1992a) position that *Riccardia latifrons* is doubtful at best as occurring in the southeastern U.S. The reports above attributed to *R. latifrons* likely represent several different *Riccardia* species. Old, sterile specimens lacking cytological features are essentially impossible to identify with confidence.

Scapania undulata (L.) Dumort.

Reported by Buch (1928) and Frye and Clark (1946), apparently based on misidentifications of *S. nemorea* (See Schuster 1974).

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VASCULAR FLORA OF TWO CONSERVATION LANDS IN CHARLOTTE AND DESOTO COUNTIES, FLORIDA AND NOTES ON THE FLORA OF FLORIDA

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ABSTRACT

To increase botanical knowledge of Charlotte and DeSoto counties, a floristic inventory were carried out on two sites along Peace River. The study documented 611 taxa. Coefficient of conservatism values was applied to reflect the quality of habitat. Data from floristic inventories within Florida were compiled to estimate species richness in other counties. Based on land area and estimates of species richness of vascular plants, counties around the Suwannee River (north Florida) and Lake Okeechobee (south-central Florida) have the least known floras.

RESUMEN

Para incrementar el conocimiento botánico de los condados de Charlotte y DeSoto, se llevó a cabo un inventario florístico en dos puntos a lo largo del Peace River. El estudio documentó 611 taxa. Se aplicaron los valores del coeficiente de conservación para reflejar la calidad del hábitat. Se compilaron datos de inventarios florísticos de Florida para estimar la riqueza de especies en otros condados. Basados en el área del terreno y estimaciones de riqueza de especies de plantas vasculares, los condados del Suwannee River (norte FL) y de Lake Okeechobee (sur-centro de Florida) tienen las floras menos conocidas.

INTRODUCTION

The currently known vascular plant species richness of the 67 counties within Florida ranges from 459 to 1706 (Wunderlin & Hansen 2008), numbers which are based on herbarium records and published accounts. The disparity is largely from a lack of voucher specimens from under-collected counties (Williams & Debelica 2008). Before this study began, about 750 vascular plant taxa had been vouchered for Charlotte Co. and 664 for DeSoto Co. (Wunderlin & Hansen 2008). In order to better understand the species richness in the flora of Florida and to more completely document the study area, a floristic inventory was carried out on conservation lands in Charlotte and DeSoto cos. (Fig. 1).

Floristic inventories can be used to judge the quality of habitat by applying coefficient of conservatism values (Wilhelm 1977; Swink & Wilhelm 1979). These values are assigned individually to taxa and have a range of 0–10, with a value of 10 representing taxa that are usually confined to unaltered, relatively pristine habitat and 0 to taxa that are common to ruderal areas. Although each number assigned is arbitrary, the comparison and assemblage of these numbers can give an estimation of habitat quality. Values have been assigned to most of the native taxa of south Florida (Mortellaro et al. 2009). These values were applied to the inventory to assess the quality of habitat.

As land area and species richness have a positive correlation (Arrhenius 1921; Williams 1943; Preston 1962), floristic inventories can also be used to estimate species richness for other lesser known areas. Williams and Debelica (2008) used various studies to estimate species richness for counties in Florida. To update species richness estimates of vascular plants for counties within Florida, a new analysis was performed to include recent county records and floristic inventories, incorporate counties with well known floras, and restrict the inclusion of data to more exhaustive inventories based on herbarium vouchers.

SITE OVERVIEW

Geography.—The Southwest Florida Water Management District (SWFWMD) owns two tracts of conservation land along Peace River: Deep Creek Preserve (DCP) and Prairie/Shell Creek (PSC) (Fig. 1). DCP contains a total of 896 ha, 876 ha in DeSoto Co. and 20 ha in Charlotte Co. PSC comprises 246 ha in Charlotte Co. At their

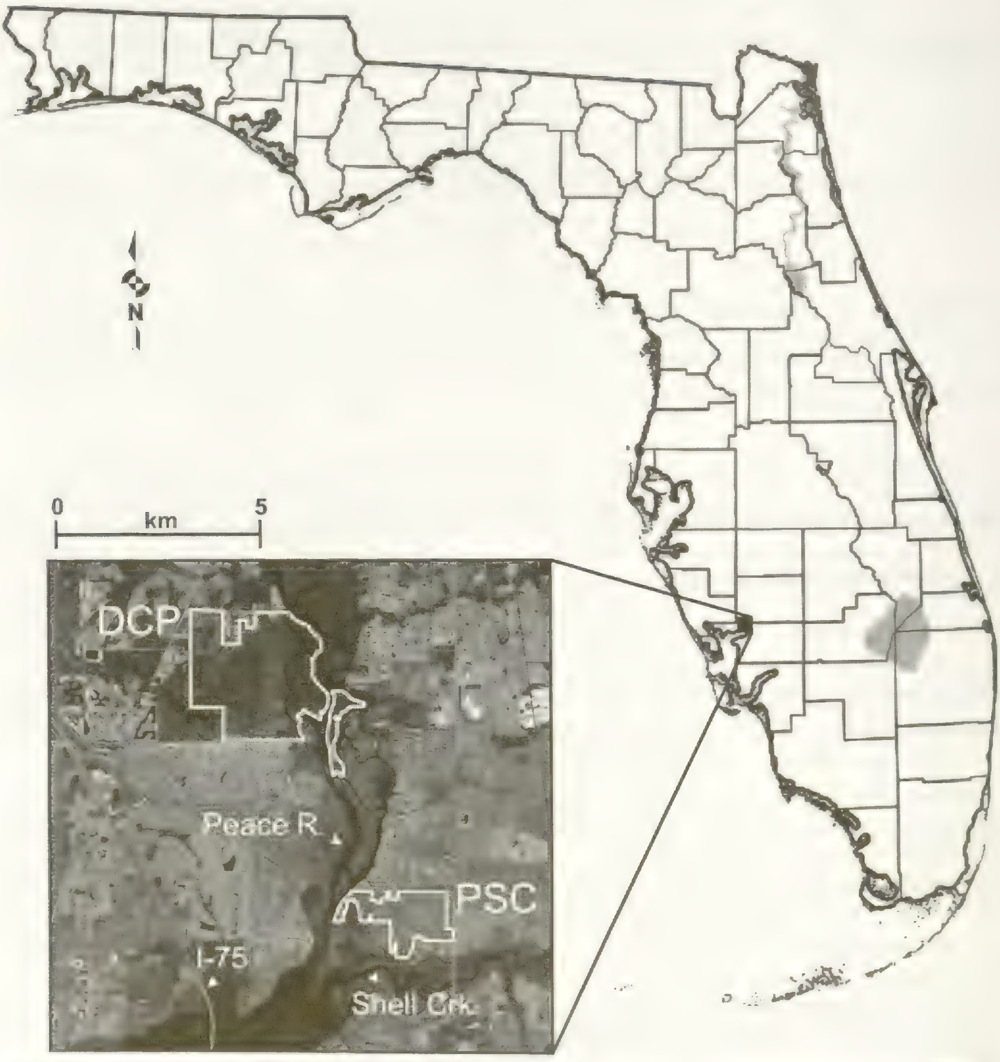

Fig. 1. Location of Deep Creek Preserve (DCP) and PSC (Prairie/Shell Creek) outlined in white. Land boundaries are approximate and do not contain navigable waters (such as Deep Creek or Peace River) or the railroad right-of-way (through PSC). Notable landmarks are labeled: Interstate 75 (I-75), Peace River (Peace R.), and Shell Creek (Shell Crk.).

closest points, DCP and PSC are about 2.8 km apart, and at their farthest points, about 10.4 km apart. DCP occupies the physiographic region of the Gulf Coastal Lowlands and PSC is within the Caloosahatchee Valley (White 1970).

DCP lies along about 4 km of the W side of Peace River, about 17 km upstream of Charlotte Harbor. The approximate center of DCP is 27°02'45"N, 82°00'20"W. The northern property boundary is marked by SW Peace River Street and a residential section at the north-central boundary. To the west is commercially-zoned fallow land, a golf driving range, and a few residential lots. Southwest of DCP lie intact flatwoods, hammocks, and marshes. To the east is Peace River, which anastomoses to form islands, some part of DCP.

PSC sits at the NE corner of the juncture of Peace River and Shell Creek, about 13 km upstream of

Charlotte Harbor. The approximate center of PSC is 26°59'30"N, 81°58'17"W. PSC is bordered by residential property to the north and southeast. There is also some pasture along the northern boundary. US 17 runs along its eastern boundary. The western and southwestern boundaries are marked by Peace River and Shell Creek. A north-south railroad bisects PSC.

Geology.—Exposed surface sediments of DCP and PSC are mostly quartz sands deposited by Pleistocene sea shores (Henderson 1984; Cowherd et al. 1989). Below the surface sediments lie undifferentiated sands and shell. The Peace River Formation occurs from 0–30 m below mean sea level and the Hawthorn Group at 30–150 m. Both consist of intermixed quartz sands, clay, and carbonates. Suwannee Limestone reaches to about 150 m below mean sea level.

Soils.—The soils of DCP and PSC are predominantly sandy, siliceous, hyperthermic haplaquods of the spodosols soil order (Henderson 1984; Cowherd et al. 1989). Spodosols refers to the presence of amorphous aluminum and organic matter. Haplaquods are characterized by a minimal horizon and a shallow, fluctuating water table. Tidally-influenced soils around waterways are hyperthermic sulfisaprists of the histosols soil order (Henderson 1984; Cowherd et al. 1989). Histosol denotes a high amount of organic material and sulfisaprists are potentially acid sulfate soils.

Topography.—Changes in elevation are nearly imperceptible except for moderate slopes around drainages and depression marshes. The maximum elevation is about 9 m at DCP (USGS 1987) and 4 m at PSC (USGS 1989). Elevation gradually descends to near sea level around Peace River and Shell Creek.

Sea Level.—During the last interglacial period about 120 Ka ago, sea levels were about 6 m above current levels. The last glacial maximum was around 18 Ka ago during the Wisconsin Glacial Episode. Sea levels then were about 120 m below current sea levels. Sea level rise was relatively rapid during the period between 6–18 Ka ago and then gradually reached current levels (Muhs et al. 2003). During the last glacial maximum, Peace River likely merged with the Myakka River before emptying out to sea (Herwitz 1977). Sea level rise has inundated this juncture, resulting in the present estuarine Charlotte Harbor (Herwitz 1977).

Hydrology.—Both properties border the southern Peace River, where it begins to form a drowned river valley and well-mixed estuary. DCP derives its name from Deep Creek, a tributary of Peace River, which starts and ends along DCP. The source of Deep Creek was once separated from Peace River by a narrow strip of forest. Between 1958 and 1968, it was artificially connected to Peace River (UF 2004–2010). PSC is derived from the Peace River tributaries Prairie Creek and Shell Creek. These creeks merge upstream of PSC and flow into the Peace River at the W end of PSC. The Peace River is harvested for drinking water at the RV Griffin Reserve, about 3 km N and upstream of DCP. The City of Punta Gorda uses Shell Creek for its source of water. Groundwater from the Peace River drainage basin is withdrawn for agriculture and industrial supply.

Peace River and Shell Creek are estuarine and experience a mixture of diurnal and semidiurnal tides with a maximum amplitude of 1 m. At the N end of DCP along Peace River, the waterways are predominantly freshwater and gradually become brackish downstream. Shell Creek is brackish along PSC.

The surficial aquifer of DCP and PSC is primarily unconfined, occurring from the upper Peace River Formation to the surface. The intermediate aquifer system lies in the Arcadia Formation, confined by the Peace River Formation. The Floridan Aquifer is confined in the Suwannee Limestone, Ocala Formation, and Avon Park Formation (Henderson 1984; Cowherd et al. 1989).

Climate.—DCP and PSC have a subtropical climate characterized by a humid, rainy, wet season (June–September) having convectional rain, frequent thunderstorms, and occasional tropical cyclones. The dry season (Oct–May) is much cooler and drier with most rain coming from cold fronts. During the warm phase (El Niño) of the Southern Oscillation (~5-year cycle), the dry season tends to be wetter than in the cool phase (La Niña). Wet season rainfall also increases during the warm phase of the Atlantic multidecadal oscillation (~70-year cycle) (PBS&J 2007). From 1915–2010, the wet season in DeSoto and Charlotte cos. averaged 81.3 cm of rainfall and 50.9 cm in the dry season (SWFWMD n.d.). Rainfall pH is approximately 4.8.

Data averaged from Tampa and Miami indicates the percent possible sunshine ranges from 75% in May to 62% in December (NCDC n.d.). The potential evapotranspiration rate is about 130 cm/yr and the actual is

about 100 cm/yr (Dohrenwend 1977). The actual evapotranspiration rate subtracted from annual rainfall leaves a surplus of about 32 cm/yr, among the lowest in the state.

NCDC data from Fort Myers, about 40 km SSE of DCP and PSC, is used to characterize wind, humidity, and temperature data. Mean wind speed is 13 km/hour, usually blowing east (NCDC n.d.). Average relative humidity in the morning ranges from 91% in September to 86% in May. Afternoon ranges are 61% in September to 47% in April. Normal daily maximum temperatures range from 33.2°C in August to 24.1°C in January. Minimums range from 23.6°C in August to 12.5°C in January. The average number of days per year at or below freezing temperatures is less than one (NCDC n.d.).

Historic Regional Vegetation.—Pollen cores from Lake Annie (ca. 65 km ENE of DCP and PSC) show a preponderance of *Ceratiola* 37 Ka to 13 Ka ago, indicative of a dry climate. There was a spike of *Quercus* around 9 Ka ago with a subsequent decrease then *Pinus* becomes much more abundant from around 5 Ka ago, remaining relatively stable since (Watts 1975). Pollen cores from Fakahatchee Strand State Park (ca. 130 km SSE of DCP and PSC) show an increase in *Taxodium* and a decline in *Pinus* around 3 Ka ago, suggesting an increase in available moisture (Donders et al. 2005).

Pollen cores from Rookery Bay (ca. 100 km SSE of DCP and PSC) show noticeable declines of *Taxodium* around 1870 and of *Pinus* around 1950, both due to intensive logging. An increase in the abundance of *Ambrosia* pollen beginning in the early 1900s and with a large spike around 1950 corresponds to an increase in anthropogenic disturbance (Donders et al. 2008).

Regional History.—The northern extent of the Calusa may have occupied and fished the area around DCP and PSC until their decline around 1700 (Widmer 1988). Spanish fishermen stayed in Charlotte Harbor from about 1750 to 1830 (Hammond 1973). Seminoles occupied areas along the Peace River and Charlotte Harbor until the 1850s (Covington 1993). Settlers began occupying nearby Punta Gorda in the 1880s (Peeples 1967) and the railroad bisecting PSC was completed in 1886 (Peeples 1980). In the 1920s the botanist J.K. Small (1922) explored and traveled through Punta Gorda, Peace River, and Prairie Creek, also documenting many specimens of the rare *Deeringothamnus* in the area. The development of Port Charlotte began in the 1950s (Anonymous 1959). In September 1960 the center of Hurricane Donna passed about 10–20 km E of PSC as a category 4 storm (NOAA n.d.). The center of Hurricane Charley passed about 15 km NW of DCP as a category 4 storm in August 2004 (NOAA n.d.), causing many pine trees to topple which were consequently salvage-logged at DCP.

Land Use.—DCP and PSC have both been grazed by cattle in the past. The NW corner of DCP was cleared before 1952 (UF 2004–2010) for pasture. It is now partly mown and contains picnic tables. Here also occurs a gravel parking lot. The NE corner of DCP has a mown lawn, paved parking lot, pavilion, restroom facilities, and a retention pond, which are all adjacent to a boat ramp on Deep Creek. An old horse stable is situated in midwestern DCP. Powerlines run through parts of PSC. A pond within the flatwoods at PSC was the result of a sand mine. The rectangular depression in the SE corner of PSC appears to have been a borrow pit. Old turpentine pots can be found in PSC. The flatwoods of DCP and PSC are usually prescribe-burned every 4–5 years. Invasive plant species are actively managed by SWFWMD. DCP is open to the public for recreational use including hiking, camping, horseback riding, fishing, and occasional hunting for feral pigs (*Sus scrofa*). PSC has hiking and fishing available.

METHODS

DCP was visited 28 times between July 2008 and August 2010 for plant collecting. PSC was visited 16 times between May 2009 and December 2010. Voucher specimens were deposited at the University of South Florida herbarium (USF). About half of the DCP and PSC specimens are databased, photographed, and currently available online (Wunderlin & Hansen 2008). Nomenclature, taxonomy, and nativity follows Wunderlin and Hansen (2003) with updates reflected on the herbarium's website *Atlas of Florida Vascular Plants* (Wunderlin & Hansen 2008).

The coefficient of conservatism values used follows Mortellaro et al. (2009). These values were made for

the taxa of south Florida which, as defined by Mortellaro et al. (2009), includes Charlotte Co. but not DeSoto Co. As this inventory includes both counties, the values were applied to the entire inventory.

To estimate species richness of vascular plants from land area, floristic inventories within Florida were compiled (Table 1). Six counties which are believed to have well known, intensively studied floras and are representative of the diverse geography of Florida were also included (Table 1). Four of these counties have the state's four largest herbaria (Thiers n.d.). Escambia Co. represents the westernmost county and has a species richness nearly equal to the counties with the four largest herbaria. Pinellas Co. was included because of its smaller size. It is adjacent to Hillsborough Co. and well represented in the USF herbarium. County flora records from Wunderlin and Hansen (2008) are updated regularly and reflect current understanding.

Many studies used by Williams and Debilica (2008) were excluded here. Studies were excluded if they were identified as surveys or checklists without supporting herbarium voucher information for the complete list. Additional reasons were too few visits (often 5 or less), a presumption by the authors of the study to be an incomplete list, or the listing of only woody plants. Roberts et al. (2006) reported 899 taxa for Jonathan Dickinson State Park, but because 38 taxa were unvouchered the species richness used was 861. Land area for Waccasassa Bay State Preserve was limited to the terrestrial portion, excluding 27.43 km^2 of submerged estuary (Abbott & Judd 2000).

Species richness counted infraspecific taxa. Both native and exotic taxa were included. Land area excluded most large, perennial open water bodies. State and county land area was obtained from the U.S. Census Bureau (n.d.). Species richness and land area (Table 1) were log-transformed and plotted. A linear regression was then performed (Fig. 2). The linear equation obtained was then used to estimate species richness in all of Florida and its counties based on its land area. The number of taxa currently known per county was then divided by its estimated species richness to yield a percent. This percent, as an estimate, then represents the percent of the flora that has been documented based on its estimated species richness (Fig. 3).

RESULTS

A combined total of 611 taxa representing 121 families and 350 genera were documented at DCP and PSC. Individually, 507 taxa were collected in DCP and 372 at PSC. There were a total of 240 county records, 78 for Charlotte Co. and 162 for DeSoto Co. The families with the most taxa were Poaceae (86), Asteraceae (77), Cyperaceae (53), and Fabaceae (41). The largest genus was *Rhynchospora* (14 taxa), followed by *Cyperus* (13), *Ludwigia* (10), *Andropogon* (9), and *Quercus* (9). Overall, 104 exotic taxa representing 17.0% of the flora were recorded. The families containing the most exotics were Poaceae (22), Fabaceae (14), and Asteraceae (9). There were 23 taxa listed as Category I by the FLEPPC (2009) and 12 Category II taxa. The Category I taxon *Pistia stratiotes* is treated as native here. One taxon, *Eucalyptus camaldulensis* subsp. *acuta*, was recorded as newly naturalized to Florida (Wunderlin et al. 2010).

There were four endangered taxa vouchered: *Lechea divaricata*, *Roystonea regia*, *Tillandsia fasciculata*, and *T. utriculata*. There were five threatened taxa vouchered: *Acrostichum aureum*, *Lilium catesbaei*, *Opuntia stricta*, *Pteroglossaspis ecristata*, and *Tillandsia balbisiana*. Four taxa recorded are categorized as commercially exploited: *Encyclia tampensis*, *Osmunda cinnamomea*, *Osmunda regalis* var. *spectabilis*, and *Zamia pumila* (Coile & Garland 2003).

Species that were collected at or near their known southern distributional limits of SW Florida include *Carex stipitata*, *Clematis crispa*, *Euthamia graminifolia*, *Gelsemium sempervirens*, *Gordonia lasianthus*, *Ludwigia palustris*, *Panicum longifolium*, *Panicum verrucosum*, *Phoebanthus grandiflorus*, *Physostegia leptophylla*, *Rhynchospora cephalantha*, *Rubus pensylvanicus*, *Rumex hastaltulus*, *Styrax americanus*, *Vaccinium stamineum*, *Vernonia gigantea*, and *Vicia floridana*. Species that were collected at or near their known northern limits of SW Florida include *Annona glabra*, *Polygonella polygama* var. *brachystachya*, *Randia aculeata*, *Roystonea regia*, and *Vernonia blodgettii*.

Native taxa that were documented and are uncommonly collected in the region include *Annona glabra*, *Chrysopogon pauciflorus*, *Cuscuta obtusiflora* var. *glandulosa*, *Hymenocallis tridentata*, *Lythrum lineare*, and

TABLE 1. Floristic inventories used for regression analysis of log land area vs. log species richness.

Site	Land area (km^2)	Log land area	Species richness	Log sp. richness	Reference
USDA Subtropical Horticultural Research Station (Miami-Dade Co.)	0.02	-1.70	159	2.20	Kabat et al. 2006
Dunedin Hammock (Hillsborough Co.)	0.34	-0.47	336	2.53	Genelle & Fleming 1978
Weaver Creek Wetland (Santa Rosa Co.)	0.55	-0.26	102	2.01	Holt 2008
Gold Head Branch Ravine (Clay Co.)	0.88	-0.06	356	2.55	White & Judd 1985
Morningside Nature Center (Alachua Co.)	1.12	0.05	511	2.71	Kabat 2003
Churchill Ranch (Sarasota Co.)	1.7	0.23	368	2.57	Franck & Wunderlin 2009
Starkey Wilderness Preserve (Pasco Co.)	4.5	0.65	483	2.68	Ferguson & Wunderlin 2006
Dog Island (Franklin Co.)	7.45	0.87	393	2.59	Anderson & Alexander 1985
Ichetucknee Springs State Park (Suwannee & Columbia cos.)	9.07	0.96	604	2.78	Herring & Judd 1995
O'Leno State Park & Northeast River Rise State Preserve (Alachua & Columbia cos.)	9.23	0.97	540	2.73	Tan & Judd 1995
Manatee Springs State Park (Levy Co.)	9.33	0.97	360	2.56	Gulledge & Judd 2002
Little Manatee River State Park (Hillsborough Co.)	9.8	0.99	523	2.72	Myers & Wunderlin 2003
Deep Creek Preserve & Prairie/Shell Creek (DeSoto & Charlotte cos.)	11.42	1.06	611	2.79	This study
Paynes Prairie State Preserve, upland (Alachua Co.)	11.6	1.06	573	2.76	Easley & Judd 1990
Cedar Key Scrub State Reserve (Levy Co.)	20.2	1.31	449	2.65	Amoroso & Judd 1995
Tiger Creek Preserve & Saddle Blanket Scrub Preserve (Polk Co.)	23.08	1.36	553	2.74	Corogin & Judd 2009
Marco Island (Collier Co.)	33.88	1.53	470	2.67	Wilder & Roche 2009
Jonathan Dickinson State Park (Martin & Palm Beach cos.)	46.42	1.67	861	2.94	Roberts et al. 2006
Paynes Prairie State Preserve, basin/hammock (Alachua Co.)	56.1	1.75	422	2.63	Patton & Judd 1986
Waccasassa Bay State Preserve (Levy Co.)	97.45	1.99	576	2.76	Abbot & Judd 2000
Myakka River State Park (Sarasota & Manatee cos.)	116.86	2.07	731	2.86	Huffman & Judd 1998
Merritt Island (Brevard & Volusia cos.)	582.75	2.77	943	2.97	Poppleton et al. 1977
Pinellas Co.	725	2.86	1196	3.08	Wunderlin & Hansen 2008
Escambia Co.	1715	3.23	1600	3.20	Wunderlin & Hansen 2008
Leon Co.	1727	3.24	1702	3.23	Wunderlin & Hansen 2008
Alachua Co.	2264	3.35	1560	3.19	Wunderlin & Hansen 2008
Hillsborough Co.	2722	3.43	1644	3.22	Wunderlin & Hansen 2008
Miami-Dade Co.	5040	3.70	1696	3.23	Wunderlin & Hansen 2008
Florida	139670	5.15	4248	3.63	Wunderlin & Hansen 2008

Roystonea regia. Exotic taxa that are uncommonly collected include *Centratherum punctatum*, *Crassocephalum crepidioides*, *Eragrostis scaligera*, *Eucalyptus camaldulensis* subsp. *acuta*, *Murdannia spirata* var. *parviflora*, and *Syagrus romanzoffiana*.

Coefficient of conservatism values range from 0–10, with a value of ten being a high confidence indicator of high quality habitat and a value of zero denoting a ruderal area. The number of native taxa found for each coefficient of conservatism value for DCP and PSC was as follows: value (10)-0 taxa, (9)-14, (8)-63, (7)-83, (6)-51, (5)-42, (4)-82, (3)-32, (2)-48, (1)-23, and (0)-12. Fifty-seven native taxa did not have a reported value. The 104 exotic taxa are assigned a coefficient of conservatism value of zero.

Regression analysis of the log species richness (y) and log land area (x) within Florida (Table 1) produced the equation $y=0.206x+2.4809$ with an R^2 value of 0.8593 (Fig. 2). The equation can be rewritten as $y=(10^{2.4809})x^{0.206}$, where y is species richness and x is land area (km^2). After applying the equation to Florida and its counties to estimate species richness (Fig. 3; Table 2), the counties estimated to have the least known floras were, in

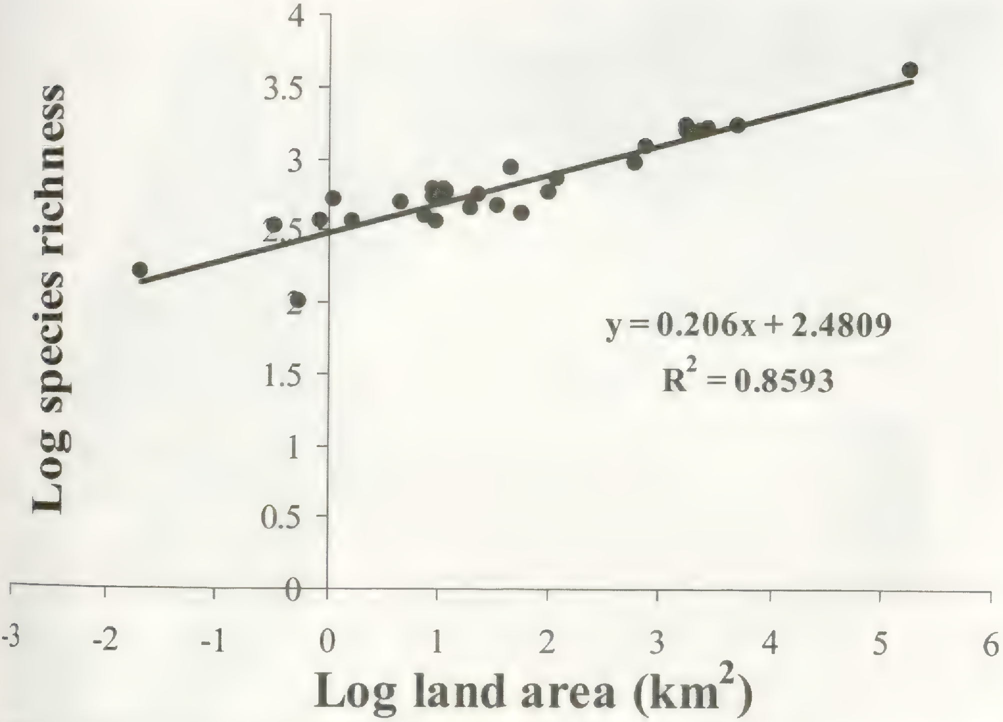

Fig. 2. Linear regression of log species richness and log land area; values are from Table 1.

ascending order, Lafayette, Hendry, Okeechobee, Glades, and Union. The counties estimated to have the most well known floras were, in descending order, Leon, Franklin, Escambia, Hillsborough, and Alachua.

PLANT COMMUNITIES

The classification for plant communities follows the Florida Natural Areas Inventory (FNAI 2010). They are grouped into eight categories: scrub, flatwoods, hammocks, marshes, baygall, tidal and floodplain, streams and lakes, and ruderal.

Scrub.—The scrub in PSC makes up a significant portion of the property and supports a population of scrub jays (*Aphelocoma coerulescens*). The scrub of DCP is inconspicuous and extremely tiny. One of the hallmarks of scrub on both properties is bare patches of sand and ground lichens such as *Cladina evansii*, *C. subtenuis*, and *Cladonia leporina*.

At PSC is a coastal pine-oak scrub. The pines consist of *Pinus clausa* and *P. palustris*; the oaks are *Quercus chapmanii*, *Q. geminata*, *Q. laevis*, *Q. minima*, and *Q. myrtifolia*. The Florida endemic herbs *Dalea pinnata* var. *adenopoda*, *Lechea divaricata*, and *Palafoxia feayi* occur here.

A small remnant of scrub exists at the northern portion of DCP at a property edge. The rest of the scrub was likely cleared for the adjacent residential lots where a few *Pinus clausa* trees remain, none occuring on DCP. The herbs *Bulbostylis warei* and *Chrysopsis scabrella* are found here.

Flatwoods.—At DCP and PSC, pyrogenic pine flatwoods compose the bulk of the landscape. Mesic flatwoods is the most common moisture regime. Wet flatwoods occurs as transition zones between mesic flatwoods and marshes and often have 10–20 cm of standing water during periods of the wet season. Scrubby flatwoods is xeric, forming the gradient of mesic flatwoods to either xeric hammock or scrub.

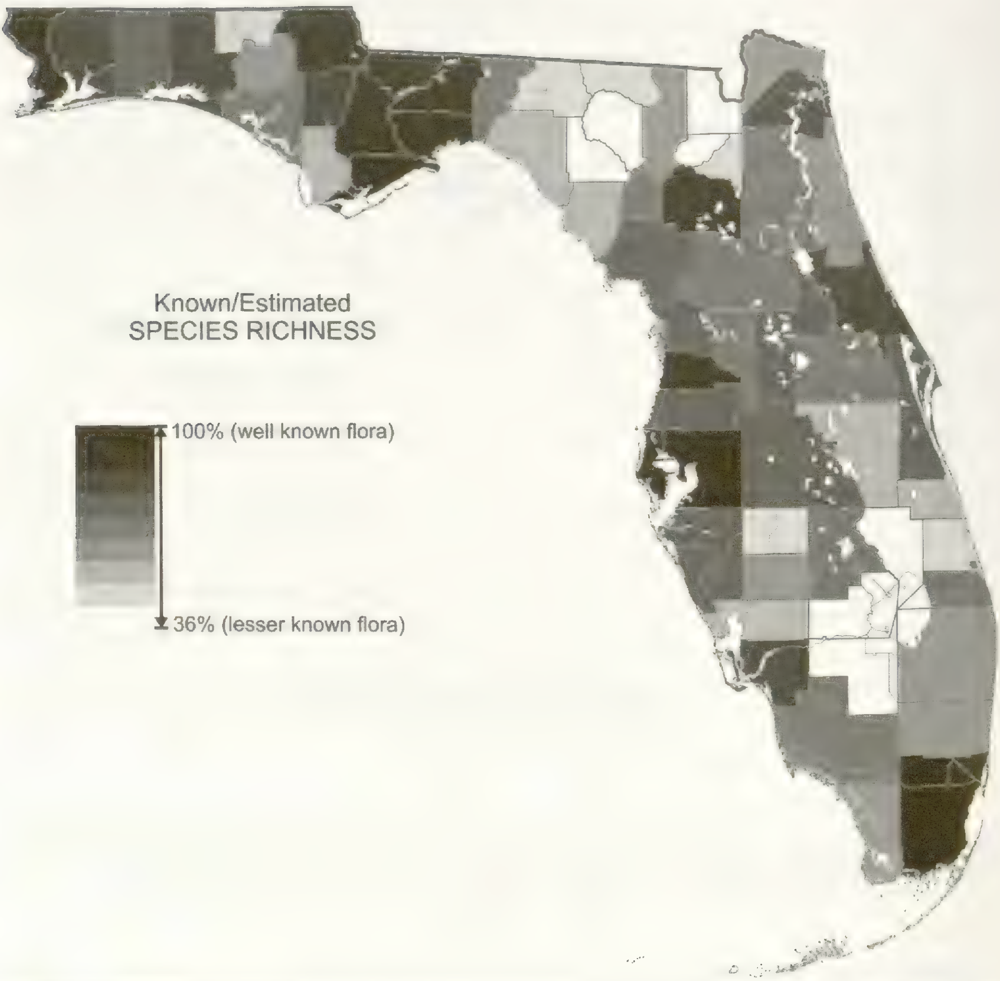

Fig. 3. Gray-scale representation of the percent of the flora that has been documented for each county in Florida based on its estimated species richness of vascular plants. Values used are from Table 2. White was used for counties with a 36–43% estimated documentation of its species richness, then progressively darker shades for 44–51%, 52–59, 60–67, 68–75, 76–83, 84–91, 92–99, and, finally, 100+ shaded as black. Water bodies have not been shaded according to the scale.

Widely-spaced trees of *Pinus palustris* form the canopy in scrubby to mesic flatwoods while a somewhat denser canopy of *P. elliottii* is more common in wet flatwoods. Among all flatwoods, sprawling *Serenoa repens* is ubiquitous in the understory. Common grasses include *Andropogon* spp., *Aristida* spp., and *Sorghastrum secundum*. Other frequent herbs are *Fimbristylis dichotoma*, *Lygodesmia aphylla*, *Polygala* spp., and *Rhynchospora fascicularis*. The threatened orchid *Pteroglossaspis ecristata* is occasional. Shrubs of *Ilex glabra*, *Lyonia* spp., *Quercus minima*, and *Vaccinium darrowii* are also frequent. Once left unburned, *Ilex glabra* and *Serenoa repens* quickly form very dense thickets in the wet flatwoods.

The herbs *Amphicarpum muehlenbergianum* and *Oclemena reticulata* are characteristic of wet flatwoods. Shrubs of the exotic *Rhodomyrtus tomentosa* are scattered about wet flatwoods at PSC. Shrubs of *Bejaria racemosa*, *Lyonia ferruginea*, *Quercus myrtifolia*, and *Vaccinium myrsinites* are more common in scrubby flat-

woods as well as the herbs *Eryngium aromaticum* and the endemic *Euphorbia polyphylla*. The cycad *Zamia pumila* is scattered about in mesic to scrubby flatwoods.

Hammocks.—The oak hammocks mainly follow the contours of drainages and are surrounded by flatwoods. As in flatwoods, *Serenoa repens* occupies nearly all hammocks to some degree.

Hydric hammock directly borders drainage streams. Common trees are *Quercus laurifolia* and *Sabal palmetto*. Shrubs of *Myrsine cubana* are fairly common. Clumps of the grass *Dichanthelium commutatum* are often present. Hydric hammock is frequently disturbed by feral pigs.

Mesic hammock surrounds the hydric hammock with a canopy composed mainly of *Quercus virginiana*. This habitat is commonly disturbed by feral pigs. A section of mesic hammock on the western edge of DCP is very disturbed with such exotic species as *Citrus ×aurantium*, *Clerodendron indicum*, *Solanum diphyllum*, and *Urena lobata*.

Xeric hammock occurs along ridges bordering perennial and temporal streams as a transition zone between flatwoods and the wetter hammock surrounding the drainages. Xeric hammock also occurs as a small patch surrounded by scrub at PSC. The canopy is composed mostly of small, shrubby to large trees of *Quercus geminata* along with shrubby *Q. chapmanii* and *Q. myrtifolia*.

Sandy, well-drained banks along Peace River support maritime hammock. Trees of *Q. virginiana* are frequent. Common shrubs are *Ardisia escallonioides*, *Chiococca alba*, and *Erythrina herbacea*. The narrow ridge of maritime hammock at PSC has some rather large tree-like examples of *Erythrina herbacea*.

Coastal hydric hammock is just inland of tidal or freshwater tidal marsh. *Sabal palmetto* is common in the canopy with shrubs of *Yucca aloifolia* below. Young immature trees of *Ficus aurea* were found here.

Marshes.—Dotted about the flatwoods are numerous depression marshes. They are usually dried-up in the winter and flooded up to about one meter in the summer. The marshes experience fire usually only along their outer edge in contact with the surrounding flatwoods. Common elements are *Hypericum fasciculata*, *Polygonum punctatum*, *Spartina bakeri*, and *Utricularia* spp. Trees of *Nyssa sylvatica* var. *biflora* associate with a few in DCP.

Basin marshes are larger and have a wider margin of wet flatwoods surrounding them than depression marshes. Common species are *Aristida palustris*, *Oxypolis filiformis*, and *Utricularia purpurea*.

Marshes within hammocks are also termed basin marshes but are rarely influenced by fire. *Cephalanthus occidentalis* grows along the margin with *Thalia geniculata* in the center. Common herbs are *Eupatorium capillifolium*, *Panicum hemitomon*, and the exotic *P. repens*. Trees of *Acer rubrum* and shrubs of *Hibiscus grandiflorus* are often found along these marshes.

Baygall.—Baygalls occur around small seepage streams that drain surrounding xeric hammock and scrubby flatwoods. Trees such as *Gordonia lasianthus*, *Ilex cassine*, and *Magnolia virginiana* occur here.

Tidal & Floodplain.—Peace River, Deep Creek, and Shell Creek all experience tidal fluctuations. Along PSC, tidal marsh and swamp border the waterways where salinity appears to favor mangrove species. Further upstream along DCP, Peace River and Deep Creek support freshwater tidal marsh and swamp. The lower-order tributaries to Deep Creek which are further inland at DCP harbor floodplain marsh and swamp. The change from tidal to freshwater tidal to floodplain is very subtle and obscure.

Tidal swamp is characterized by the mangroves *Laguncularia racemosa* and *Rhizophora mangle*. *Avicennia germinans* is rare. At the inland fringe of the swamp is *Conocarpus erectus*; further inland the community transitions to tidal marsh. Common components of the tidal marsh are *Acrostichum danaeifolium*, *Baccharis angustifolia*, *Distichlis spicata*, and *Juncus roemerianus*. Other notable species are *Amaranthus australis*, *Ammannia latifolia*, and *Eleocharis albida*.

Freshwater tidal marsh contains dense colonies of *Acrostichum danaeifolium* with marginal lines of *Schoenoplectus californicus* and *Typha domingensis*. *Juncus roemerianus* is occasional. Small colonies of *Crinum americanum* are frequent. Common vines are *Ipomoea sagittata* and *Sarcostemma clausum*.

Freshwater tidal swamp typically has trees of *Annona glabra* and *Persea palustris*. Trees of *Carya aquatica* are occasional in the N portion of Deep Creek. The exotic invasive *Schinus terebinthifolia* has extensively colo-

nized and disrupted this habitat in many areas. The mangroves *Laguncularia racemosa* and *Rhizophora mangle* are sparse and scattered; the more salt-tolerant mangrove *Avicennia germinans* is absent. Three *Roystonia regia* trees also occur in this habitat. A few more occur off site as well.

The floodplain swamp often has a canopy of *Taxodium ascendens*, *T. distichum*, and *Quercus laurifolia* with *Fraxinus caroliniana* and *Ulmus americana* in the subcanopy. Shrubs include *Cephalanthus occidentalis* and *Itea virginica*. The herbs *Crinum americanum* and *Hymenocallis tridentata* are scattered throughout. Floodplain swamp is commonly disturbed by feral pigs.

A small pocket of floodplain marsh occurs near the juncture of Deep Creek and its main tributary. Species such as *Eleocharis albida*, *Eupatorium serotinum*, and *Symphyotrichum bahamense* are frequent.

Streams & Lakes.—Tributaries to Deep Creek and Shell Creek represent the only examples of blackwater stream that are strictly on SWFWMD property. Floating aquatics are *Landoltia punctata* and *Pistia stratiotes*. The submergent *Hydrilla verticillata* and the emergent *Sagittaria filiformis* also occur here.

The artificial pond at PSC represents a flatwoods lake community. The herbs *Hydrocotyle umbellata* and *Typha domingensis* grow along the margin with *Salix caroliniana*.

Ruderal.—At DCP ruderal areas are formed by trails, firebreaks, fencerows, powerline right-of-ways, lawns, parking lots, a decrepit horse stable, a campground, and an old pasture. The ruderal areas of PSC are mainly trails and powerline right-of-ways. The native *Paspalum setaceum* and the exotic lawn grass *Paspalum notatum* var. *saurae* are especially common and characteristic.

DISCUSSION

Most of the habitats of DCP and PSC appear relatively unaltered from their natural state. The flatwoods are prescribe-burned every 4–5 years in accordance with historical burn cycles (Huffman 2006) which helps to maintain an open canopy and groundcover amenable to perennial herbs. There were 160 taxa recorded that had coefficient of conservatism values of 7–9, indicative of high quality habitat. The 175 taxa with values of 4–6 correspond to the presence of low quality natural habitat. A significant amount of unnatural disturbance and ruderal area is evidenced by the 103 taxa with values of 1–3 as well as the 12 native taxa and 104 exotic taxa with values of zero. As these values were developed for south Florida (Mortellaro et al. 2009) and DCP and PSC are at the northern limit of its intended range, these values may not be optimally applied here.

Scrub along the coast of southwest Florida is infrequent and discontinuous (Jackson 1973; Myers 1990). Many county records were recorded from the scrub at PSC, such as *Dalea pinnata*, *Lechea divaricata*, *Quercus laevis*, and *Pinus clausa*. Along southwest Florida, these species are also disjunct in coastal scrub in Naples (ca. 80 km SSE of PSC). Scrub was probably more extensive historically (Watts 1975) and may have been confluent from Naples through Estero to PSC during lower sea levels. Pine flatwoods appear to have replaced scrub due to an increase in available moisture.

Mangrove frequency along DCP is currently patchy but expected to increase with increasing salinity due to current trends of sea level rise (Doyle et al. 2010). Large-scale ground water withdrawal from the Peace River drainage basin for use in agriculture and industrial supply has been implicated in reducing freshwater discharge (Hammett 1990; Lewelling et al. 1998), which would also lead to an increase in salinity upstream. However, seasonally-adjusted flows are reported not to reveal this causality (PBS&J 2007).

Most exotic taxa were collected in ruderal sites or along habitat edges grading into ruderal sites. Some were seen only next to residential lots, such as *Avena fatua* var. *sativa*, *Cyperus esculentus*, *Enterolobium contortisiliquum*, *Sansevieria trifasciata*, *Sorghum bicolor*, and *Syagrus romanzoffiana*. It has been purported that urban areas, especially residential areas (Vidra and Shear 2008; Gavier-Pizarro et al. 2010a; Gavier-Pizarro et al. 2010b), contribute most to the introduction of exotics (Duguay et al. 2007). Residential yard waste, as well as other trash, was often observed at DCP and PSC. Yard waste included *Crinum* sp., *Cycas* sp., and *Pachypodium* sp., of which material of *Crinum* sp. appeared to be still viable. Other species were observed strictly around sod placed around a retention pond in DCP such as the exotics *Ipomoea quamoclit* and *Senna obtusifolia* as well as the natives *Geranium carolinianum* and *Plantago virginica*.

Few exotics appeared to be substantially invading and influencing natural habitats, partly because they are actively controlled by SWFWMD. *Schinus terebinthifolia* is probably the most troublesome exotic at DCP and PSC, in some places dominating hammocks and swamps along the Peace River. Many of the infestations are difficult to access, so control may not be attainable. Another major exotic is *Panicum repens* which forms dense, rhizomatous colonies in some marshes. There are also stands of *Ludwigia peruviana* in floodplain swamp that appear disruptive to the habitat. The exotic *Urena lobata* seemed to invade hammocks that were disturbed by feral pigs and is probably dispersed by them.

Melaleuca quinquenervia would likely be invading much of the natural habitats of PSC without control as it is prevalent in surrounding unmanaged wet flatwoods. The vining ferns *Lygodium japonicum* and *L. microphyllum* also require vigilant control as they continuously appear in wet hammocks and swamps.

Eucalyptus camaldulensis subsp. *acuta* was documented at PSC as new to the state (Wunderlin et al. 2010). This species is adapted to flooding but sensitive to fire (Dexter 1978). It has been grown in Florida (Webb 1983; Pappas & Sheppard-Hanger 2000). The majority of the population is along the railroad bisecting PSC, perhaps spread from harvested trees transported by rail. A small population of *Liquidambar styraciflua* is also present along the railroad and one tree was observed in wet flatwoods at PSC. It appears to be an introduction.

The occurence of *Roystonea regia* at DCP could be interpreted as native or escaped from cultivation. As the species is popular in cultivation, it seems probable that it is an escape. This species has been reported as naturalized in Jonathan Dickinson State Park in southeast Florida (Roberts et al. 2006) as well as in Panama (Svenning 2002). The *Roystonea* trees at DCP currently represent the northernmost vouchered population, although there was a description of palms attributed to *Roystonea* occurring along St. Johns River (Bartram 1791).

At the beginning of the study, Charlotte Co. had about 750 vouchered vascular plant taxa and DeSoto Co. had 664. New county records from this study now represent about 9% and 19%, respectively, of the counties' currently known flora. Still, it is estimated that only 59% and 60%, respectively, of these two counties' floras are documented (Table 2).

The Florida counties which were estimated to have the least documented floras were clustered around two geographic areas, the Suwannee River and Lake Okeechobee, as in Williams and Debelica (2008). The estimated county species richness for all counties are likely underestimates as some counties exceed their estimates. This is also partly true because the regression used inventories that almost assuredly would never be complete.

ANNOTATED LIST OF VASCULAR PLANTS

The plant list is grouped into Ferns (Pteridophyta), Gymnosperms, Basal Angiosperms (Nymphaenae), Magnoliids (Magnolianae), Monocots (Lilianae), and Eudicots. Within these six groups, families are listed alphabetically, and within each family, the taxa are alphabetical by genus and species. Following each species name is its authorship, habitat where the voucher specimen was collected, and the senior author's collection number. For taxa collected at both DCP and PSC, habitat and the collection numbers of DCP are given first followed by PSC. If only one habitat is listed for a taxon then it applies to all collections of that taxon. Letters preceding collection numbers are D for DCP and P for PSC. The habitat abbreviations are **BG**–baygall, **BM**–basin marsh, **BS**–blackwater stream, **CHH**–coastal hydric hammock, **DM**–depression marsh, **FL**–flatwoods lake, **FM**–floodplain marsh, **FS**–floodplain swamp, **FTM**–freshwater tidal marsh, **FTS**–freshwater tidal swamp, **HH**–hydric hammock, **MaH**–maritime hammock, **MF**–mesic flatwoods, **MH**–mesic hammock, **RU**–ruderal areas, **SC**–scrub, **SF**–scrubby flatwoods, **TM**–tidal marsh, **TS**–tidal swamp, **WF**–wet flatwoods, and **XH**–xeric hammock. Annotations preceding taxa are * for exotic species,[I] for FLEPPC category I, and [II] for FLEPPC category II.

FERNS (PTERIDOPHYTA)

Azollaceae

Azolla filiculoides Lam.—BS; *D-948*

Blechnaceae

Blechnum serrulatum Rich.—HH; D-768, *P-1912*

Woodwardia areolata (L.) T. Moore—MH; *D-1543*

Woodwardia virginca (L.) Sm.—DM; *D-1362*

TABLE 2. Land area (U.S. Census Bureau n.d.), estimated species richness, known species richness (Wunderlin & Hansen 2008), and ratio of known:estimated species richness for Florida and its counties.

	Land area (km^2)	Estimated sp. rich.	Known sp. rich.	Known / Estimated		Land area (km^2)	Estimated sp. rich.	Known sp. rich.	Known / Estimated
FLORIDA	139670	3474	4252	1.22	Lake	2469	1513	1238	0.82
Alachua	2264	1486	1566	1.05	Lee	2081	1460	1280	0.88
Baker	1516	1368	585	0.43	Leon	1727	1405	1706	1.21
Bay	1978	1445	1078	0.75	Levy	2897	1563	1242	0.79
Bradford	759	1186	529	0.45	Liberty	2165	1472	1358	0.92
Brevard	2637	1533	1180	0.77	Madison	1792	1416	645	0.46
Broward	3122	1588	1065	0.67	Manatee	1919	1436	1136	0.79
Calhoun	1469	1359	1155	0.85	Marion	4089	1678	1251	0.75
Charlotte	1796	1417	840	0.59	Martin	1439	1354	1007	0.74
Citrus	1512	1367	1133	0.83	Miami-Dade	5040	1752	1696	0.97
Clay	1557	1376	996	0.72	Monroe	2582	1527	1023	0.67
Collier	5246	1767	1273	0.72	Nassau	1688	1399	934	0.67
Columbia	2064	1458	947	0.65	Okaloosa	2423	1507	1210	0.80
DeSoto	1651	1392	834	0.60	Okeechobee	2005	1449	578	0.40
Dixie	1823	1421	753	0.53	Orange	2350	1497	1104	0.74
Duval	2004	1449	1244	0.86	Osceola	3424	1618	930	0.57
Escambia	1715	1403	1599	1.14	Palm Beach	5113	1757	1055	0.60
Flagler	1256	1316	804	0.61	Pasco	1929	1438	1146	0.80
Franklin	1410	1348	1545	1.15	Pinellas	725	1175	1196	1.02
Gadsden	1337	1333	1314	0.99	Polk	4855	1739	1370	0.79
Gilchrist	904	1230	914	0.74	Putnam	1870	1429	1046	0.73
Glades	2004	1449	582	0.40	Santa Rosa	2634	1533	1282	0.84
Gulf	1436	1353	766	0.57	Sarasota	1480	1361	1084	0.77
Hamilton	1333	1332	636	0.48	Seminole	798	1199	901	0.75
Hardee	1651	1392	635	0.46	St. Johns	1577	1379	871	0.63
Hendry	2985	1573	564	0.36	St. Lucie	1483	1362	688	0.51
Hernando	1239	1312	1222	0.93	Sumter	1413	1349	945	0.70
Highlands	2663	1537	1116	0.73	Suwannee	1781	1414	614	0.43
Hillsborough	2722	1543	1644	1.07	Taylor	2699	1541	851	0.55
Holmes	1250	1315	608	0.46	Union	622	1139	459	0.40
Indian River	1303	1326	746	0.56	Volusia	2857	1559	1336	0.86
Jackson	2372	1500	1468	0.98	Wakulla	1571	1378	1434	1.04
Jefferson	1548	1374	986	0.72	Walton	2739	1545	1317	0.85
Lafayette	1406	1347	481	0.36	Washington	1502	1366	841	0.62

Dennstaedtiaceae

Pteridium aquilinum (L.) Kuhn var. *caudatum* (L.) Sadeb.—MaH; *D-867*

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Clute ex A. Heller—MH; *D-1555, P-1925*

Nephrolepidaceae

Nephrolepis exaltata (L.) Schott—MH; *D-1122*

Osmundaceae

Osmunda cinnamomea L.—HH; *D-972, P-1793*

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray—FS; *D-820, P-1815*

Polypodiaceae

Phlebodium aureum (L.) J. Sm.—HH; *D-1103, P-2479*

Pleopeltis polypodioides (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham—MH; *D-1597*

Pteridaceae

Acrostichum aureum L.—TM; *P-2493*

Acrostichum danaeifolium Langsd. & Fisch.—FTM; *D-793, P-2403*

**Ceratopteris thalictroides* (L.) Brongn.—FM, TM; *D-993, P-2406*

II*Pteris vittata* L.—HH; *D-756*

Salviniaceae

I*Salvinia minima* Baker—BS; *D-946*

Schizaeaceae

I*Lygodium japonicum* (Thunb.) Sw.—HH; *D-942*

I*Lygodium microphyllum* (Cav.) R. Br.—HH; *D-975*

Thelypteridaceae

**Thelypteris dentata* (Forssk.) E.P. St. John—HH; *D-944, P-2478*

Thelypteris interrupta (Willd.) K. Iwats.—HH, BG; *D-1077, P-2449*

Thelypteris kunthii (Desv.) C.V. Morton—HH, RU; *D-1074, P-2525*

Thelypteris palustris Schott—FS; *D-1098*

Vittariaceae

Vittaria lineata (L.) Sm.—HH; *D-983, P-1916*

GYMNOSPERMS

Cupressaceae

Taxodium ascendens Brongn.—FS; *D-844*

Taxodium distichum (L.) Rich.—FS; *D-967*

Pinaceae

Pinus clausa (Chapm. ex Engelm.) Vasey ex Sarg.—SF; *P-1270*
Pinus elliottii Engelm.—WF; *D-1179, P-1410*
Pinus palustris Mill.—SF; *D-1137, P-1802*

Zamiaceae

Zamia pumila L.—SF, SC; *D-748, P-1257*

BASAL ANGIOSPERMS (NYMPHAEANAE)

Nymphaeaceae

Nymphaea odorata Aiton—DM; *P-1989*

MAGNOLIIDS (MAGNOLIANAE)

Annonaceae

Anonna glabra L.—FTS, TM; *D-848, P-2496*
Asimina reticulata Shuttlew. ex Chapm.—MF; *D-1135, P-1348*

Lauraceae

Cassytha filiformis L.—MF; *D-813*
[I]*Cinnamomum camphora* (L.) J. Presl—HH; *D-955*
Persea borbonia (L.) Spreng.—XH; *D-839*
Persea borbonia (L.) Spreng. var. *humilis* (Nash) L.E. Kopp—XH; *D-1737*
Persea palustris (Raf.) Sarg.—FTS, CHH; *D-862, P-1940*

Magnoliacae

Magnolia virginiana L.—WF, HH; *D-918, P-1239*

Saururaceae

Saururus cernuus L.—FS; *D-1197*

MONOCOTS (LILIANAE)

Agavaceae

Yucca aloifolia L.—CHH; *D-1727, P-2460*
Yucca filamentosa L.—SF; *D-1356*

Alismataceae

Sagittaria filiformis J.G. Sm.—BS; *D-1063, P-2445*
Sagittaria graminea Michx.—BM; *D-905, P-1987*
Sagittaria lancifolia L.—BM; *D-912*

Amaryllidaceae

Crinum americanum L.—FTM; *D-857, P-2450*
Hymenocallis tridentata Small—FS; *D-1149*

Araceae

[I]*Colocasia esculenta* (L.) Schott—FTM; *D-1017*
[II]*Landoltia punctata* (G. Mey.) Les & D.J. Crawford—BS; *D-818*
Orontium aquaticum L.—BS; *P-2446*
Peltandra virginica Raf.—FTM; *D-1024*
[I]*Pistia stratiotes* L.—BS; *D-1598*
Spirodela polyrhiza (L.) Schleid.—BS; *D-1151*

Arecaceae

[II]*Phoenix reclinata* Jacq.—WF; *P-2040*
Roystonea regia (Kunth) O.F. Cook—FTS; *D-1025*
Sabal palmetto (Walter) Lodd. ex Schult. & Schult. f.—XH, CHH; *D-759, P-2408*
Serenoa repens (W. Bartram) Small—MF, SC; *D-2280, P-2298*
[II]*Syagrus romanzoffiana* (Cham.) Glassman—HH, MF; *D-841, P-1942*

Bromeliaceae

Tillandsia balbisiana Schult. & Schult. f.—FTS; *D-883*
Tillandsia fasciculata Sw.—MaH, XH; *D-873, P-1801*
Tillandsia recurvata (L.) L.—SF, SC; *D-1299, P-2006*
Tillandsia setacea Sw.—HH; *D-1602*
Tillandsia usneoides (L.) L.—MH; *D-1528, P-1941*
Tillandsia utriculata L.—FTS, XH; *D-1019, P-1403*

Cannaceae

Canna flaccida Salisb.—DM; *D-2165*

Commelinaceae

Callisia ornata (Small) G.C. Tucker—SF, SC; *D-2158, P-2002*
**Commelina diffusa* Burm. f.—RU; *D-877, P-1935*
Commelina erecta L.—SC; *P-1338*
**Commelina gambiae* C.B. Clarke—RU; *D-1729*
**Murdannia spirata* (L.) G. Brückn. var. *parviflora* Faden—MH; *D-1048*

Cyperaceae

**Bulbostylis barbata* (Rottb.) C. B. Clarke—RU; *D-876, P-2429*
Bulbostylis ciliatifolia (Elliott) Fernald—SC; *P-1342*
Bulbostylis stenophylla (Elliott) C. B. Clarke—RU; *D-766*
Bulbostylis warei (Torr.) C. B. Clarke—SC; *D-1224, P-1498*
Carex longii Mack.—HH; *D-1035*
Carex lupuliformis Sartw. ex Dewey—HH; *P-1964*
Carex stipata Muhl. ex Willd.—FS; *D-1196*
Carex vexans F.J. Herm.—HH; *D-914*
Cladium jamaicense Crantz—BM; *D-769*
Cyperus compressus L.—RU; *P-1414*
Cyperus croceus Vahl—RU; *D-765, P-1930*
Cyperus distinctus Steud.—FM; *D-987*
**Cyperus esculentus* L.—RU; *D-2161*
Cyperus haspan L.—FTM; *D-1022, P-2436*
Cyperus lecontei Torr. ex Steud.—RU; *P-2523*
Cyperus ligularis L.—CHH, HH; *D-1016, P-2545*
Cyperus odoratus L.—FM; *D-951*
Cyperus ovatus Baldwin—MF; *D-1360, P-1341*
Cyperus polystachyos Rottb.—HH; *D-1007, P-1958*
Cyperus strigosus L.—HH; *P-2476*
Cyperus surinamensis Rottb.—HH, RU; *D-947, P-1898*
Cyperus virens Michx.—HH; *P-1979*
Eleocharis albida Torr.—FM, CHH; *D-991, P-2465*
Eleocharis baldwinii (Torr.) Chapm.—WF; *D-915, P-2435*
Eleocharis flavescens (Poir.) Urb.—HH; *P-2544*
Eleocharis interstincta (Vahl.) Roem. & Schult.—FM; *D-799*
**Eleocharis nigrescens* (Nees) Steud.—WF; *D-917*
Fimbristylis cymosa R. Br.—RU; *D-1564, P-2405*
Fimbristylis dichotoma (L.) Vahl—MF; *D-823*
**Fimbristylis schoenoides* (Retz.) Vahl—RU; *P-1499*
Fimbristylis spadicea (L.) Vahl—CHH; *P-2461*
Fuirena breviseta (Coville) Coville—RU; *D-1061*
Fuirena scirpoidea Michx.—DM, WF; *D-1821, P-1960*
**Kyllinga brevifolia* Rottb.—RU; *D-1566*
Lipocarpha micrantha (Vahl) G. C. Tucker—HH; *D-1059*
Rhynchospora cephalantha A. Gray—DM; *D-803*
Rhynchospora colorata (L.) H. Pfeiff.—FM; *D-1090, P-1974*
Rhynchospora divergens Chapm. ex M.A. Curtis—DM; *P-1984*
Rhynchospora fascicularis (Michx.) Vahl—MF; *D-801, P-2483*
Rhynchospora filifolia A. Gray—DM; *D-1295, P-2434*
Rhynchospora globularis (Chapm.) Small—HH; *P-2044*
Rhynchospora inundata (Oakes) Fernald—FTM; *D-850*
Rhynchospora intermedia (Chapm.) Britton—SF; *D-1195, P-1998*
Rhynchospora megalocarpa A. Gray—XH; *D-1735, P-1405*
Rhynchospora microcarpa Baldwin ex A. Gray—DM, WF; *D-1359, P-1350*
Rhynchospora microcephala (Britton) Britton ex Small—WF; *D-1828, P-2481*
Rhynchospora odorata C. Wright ex Griseb—FM; *D-795*
Rhynchospora plumosa Elliott—MF; *D-1298, P-2030*
Rhynchospora tracyi Britton—BM; *D-933, P-2290*
Schoenoplectus californicus (C. A. Mey.) Soják—FTM; *D-886*
Scleria ciliata Michx.—MF, SC; *D-2132, P-1997*
Scleria reticularis Michx.—RU; *D-906, P-2438*
Scleria triglomerata Michx.—XH; *D-1056*

Dioscoreaceae
[I]_Dioscorea bulbifera_ L.—RU; _D-1055_

Eriocaulaceae
Eriocaulon compressum Lam.—BM; _D-1123_
Eriocaulon decangulare L.—WF; _D-924, P2535_
Lachnocaulon anceps (Walter) Morong—MF; _D-1104, P-2543_
Lachnocaulon beyrichianum Sporl. ex Körn.—SC; _P-2302_
Syngonanthus flavidulus (Michx.) Ruhland—BM, DM; _D-1141, P-1996_

Haemodoraceae
Lachnanthes caroliniana (Lam.) Dandy—WF, DM; _D-777, P-1254_

Hydrocharitaceae
[I]_Hydrilla verticillata_ (L.f.) Royle—BS; _D-827_

Hypoxidaceae
Hypoxis curtissii Rose—HH; _D-1078_
Hypoxis juncea Sm.—SF, SC; _D-1043, P-2007_

Iridaceae
Iris hexagona Walter—FS; _D-1147_
Sisyrinchium angustifolium Mill.—RU; _D-1169_
Sisyrinchium nashii E.P. Bicknell—SF; _D-2139_
Sisyrinchium xerophyllum Greene—SC; _P-2293_

Juncaceae
Juncus effusus L. subsp. _solutus_ (Fernald & Wiegand) Hämet-Ahti—FTS, HH; _D-997, P-1265_
Juncus marginatus Rostk.—RU; _D-1037, P-1893_
Juncus megacephalus M.A. Curtis—HH; _D-2160_
Juncus repens Michx.—RU; _D-2167_
Juncus roemerianus Scheele—FTM; _D-1164, P-1855_
Juncus scirpoides Lam.—MF; _D-1102_

Liliaceae
Lilium catesbaei Walter—MF; _D-977_

Marantaceae
Thalia geniculata L.—BM, HH; _D-1117, P-2547_

Orchidaceae
Encyclia tampensis (Lindl.) Small—HH; _D-1183_
Habenaria floribunda Lindl.—RU; _D-1042_
Pteroglossaspis ecristata (Fernald) Rolfe—MF; _D-835_
Spiranthes praecox (Walter) S. Watson—MF; _P-1953_
*_Zeuxine strateumatica_ (L.) Schltr.—RU; _D-1111_

Poaceae
Amphicarpum muhlenbergianum (Schult.) Hitchc.—WF; _D-817, P-1408_
Andropogon brachystachyus Chapm.—HH; _P-2471_
Andropogon floridanus Scribn.—SF; _D-1040, P-2417_
Andropogon glomeratus (Walter) Britton et al. var. _glaucopsis_ (Elliott) C. Mohr—WF; _P-2387_
Andropogon glomeratus (Walter) Britton et al. var. _hirsutior_ (Hack.) C. Mohr—HH; _P-2393_
Andropogon glomeratus (Walter) Britton et al. var. _pumilus_ (Vasey) Vasey ex L.H. Dewey—FM; _D-1001, P-2430_
Andropogon longiberbis Hack.—MH, WF; _D-1066, P-1409_
Andropogon ternarius Michx.—SF; _D-1041, P-2397_
Andropogon virginicus L. var. _decipiens_ C. S. Campb.—SF; _D-1547, P-2398_
Andropogon virginicus L. var. _glaucus_ Hack.—RU; _D-1036, P-2402_
Aristida palustris (Chapm.) Vasey—BM; _D-919, P-2534_
Aristida patula Chapm. ex Nash—HH; _P-2401_
Aristida purpurascens Poir. var. _tenuispica_ (Hitchc.) Allred— _D-1045, P-2419_
Aristida spiciformis Elliott—WF; _D-938, P-2437_
Aristida stricta Michx.—MF, WF; _D-1534, P-1819_
*_Avena fatua_ L. var. _sativa_ (L.) Hausskn.—RU; _D-2154_
Axonopus compressus (Sw.) P. Beauv.—RU; _P-2028_
Axonopus fissifolius (Raddi) Kuhlm.—RU; _D-1212_
Axonopus furcatus (Flüggé) Hitchc.—RU; _P-2034_
Cenchrus echinatus L.—MaH; _D-866_
Cenchrus spinifex Cav.—RU; _P-2027_
Chrysopogon pauciflorus (Chapm.) Benth. ex Vasey—MF; _D-976_
*_Cynodon dactylon_ (L.) Pers.—RU; _D-1572, P-1957_
[II]_Dactyloctenium aegyptium_ (L.) Willd. ex Asch. & Schweinf.—RU; _D-1517, P-2520_
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark—MF; _P-1887_
Dichanthelium commutatum (Schult.) Gould—HH; _D-1075, P-1911_
Dichanthelium dichotomum (L.) Gould—FS; _D-1229_
Dichanthelium ensifolium (Baldwin ex Elliott) Gould—MH; _D-1824_
Dichanthelium ensifolium (Baldwin ex Elliott) Gould var. _unciphyllum_ (Trin.) B.F. Hansen & Wunderlin—DM; _P-1990_
Dichanthelium erectifolium (Nash) Gould & C.A. Clark—BM; _P-1344_
Dichanthelium portoricense (Desv. ex Ham.) B.F. Hansen & Wunderlin—SC; _P-2003_
Dichanthelium strigosum (Muhl. ex Elliott) Freckmann var. _glabrescens_ (Griseb.) Freckmann—WF; _P-2433_
Digitaria ciliaris (Retz.) Koeler—RU; _D-2135, P-2385_
Digitaria insularis (L.) Fedde—RU; _P-2414_
*_Digitaria longiflora_ (Retz.) Pers.—RU; _D-833_
Digitaria violascens Link—SC; _P-2297_
Distichlis spicata (L.) Greene—TM; _P-2407_
Echinochloa muricata (P. Beauv.) Fernald—RU; _D-1053_
Echinochloa paludigena Wiegand—BM; _P-2492_
Echinochloa walteri (Pursh) A. Heller—RU; _D-2164_
*_Eragrostis atrovirens_ (Desf.) Trin. ex Steud.—RU; _P-1347_
*_Eragrostis ciliaris_ (L.) R. Br.—RU; _D-1563_
Eragrostis elliottii S. Watson—BM; _P-2533_
*_Eragrostis scaligera_ Salzm. ex Steud.—RU; _D-1513, P-2431_
Eragrostis spectabilis (Pursh) Steud.—SF; _P-2413_
Eragrostis virginica (Zuccagni) Steud.—HH, WF; _D-982, P-2389_
Eustachys glauca Chapm.—FS; _D-986_
Eustachys petraea (Sw.) Desv.—RU; _D-1569, P-1880_
*_Heteropogon contortus_ (L.) P. Beauv. ex Roem. & Schult.—RU; _P-2497_
[I]_Hymenachne amplexicaulis_ (Rudge) Nees—RU; _P-2376_
[II]_Hyparrhenia rufa_ (Nees) Stapf—RU; _P-2538_
[I]_Imperata cylindrica_ (L.) P. Beauv.—FS, RU; _D-1227, P-1900_
Leersia hexandra Sw.—DM; _D-800, P-1956_
*_Lolium perenne_ L.—RU; _D-2156_
Luziola fluitans (Michx.) Terrell & H. Rob—DM; _P-2289_
[I]_Melinis repens_ (Willd.) Zizka—RU; _D-1012, P-1888_
Oplismenus hirtellus (L.) P. Beauv.—HH; _D-1071_
Panicum anceps Michx.—MH, MF; _D-904, P-2404_
Panicum dichotomiflorum Michx. var. _bartowense_ (Scribn. & Merr.) Fernald—RU; _D-1556_
Panicum hemitomon Schult.—BM; _D-767, P-1292_
Panicum hians Elliott—WF; _P-1970_
Panicum longifolium Torr.—WF; _P-2530_
[II]_Panicum maximum_ Jacq.—RU; _D-940_
[I]_Panicum repens_ L.—BM, RU; _D-754, P-1986_
Panicum rigidulum Bosc ex Nees—FS, HH; _D-974, P-2392_
Panicum virgatum L.—FM; _D-797, P-2388_
*_Paspalum notatum_ Flüggé var. _saurae_ Parodi—RU; _D-750, P-2037_
Paspalum plicatulum Michx.—RU; _D-2153, P-1980_
Paspalum setaceum Michx.—RU; _D-1211, P-1882_
*_Paspalum urvillei_ Steud.—RU; _D-1214, P-1415_
Phragmites australis (Cav.) Trin. ex Steud.—FTM; _D-1009, D-1161_
Piptochaetium avenacioides (Nash) Valencia & Costas—SC; _P-2000_
Saccharum giganteum (Walter) Pers.—FM; _D-996, P-2391_

**Sacciolepis indica* (L.) Chase—RU; *D-2282, P-2029*
Sacciolepis striata (L.) Nash—DM; *D-804*
Schizachyrium scoparium (Michx.) Nash—MF; *D-903, P-2379*
Setaria parviflora (Poir.) Kerguélen—RU; *D-1357, P-1966*
Sorghastrum secundum (Elliott) Nash— SF; *D-1002, P-2400*
**Sorghum bicolor* Moench—RU; *P-2412*
Spartina bakeri Merr.—DM, HH; *D-1830, P-1928*
**Sporobolus indicus* (L.) R. Br. var. *pyramidalis* (P. Beauv.) Veldkamp—RU; *D-1213, P-1881*
Sporobolus junceus (P. Beauv.) Kunth—SF, SC; *D-2159, P-2004*
Stenotaphrum secundatum (Walter) Kuntze—FTM, RU; *D-852, P-2495*
Tripsacum dactyloides (L.) L.—HH; *D-798*
**Urochloa distachya* (L.) T.Q. Nguyen—RU; *D-784*
|Urochloa mutica (Forssk.) T.Q. Nguyen—RU; *P-2522*

Pontederiaceae
Pontederia cordata L.—BM; *D-911*

Ruscaceae
**Sansevieria trifasciata* Prain—RU; *D-1734*

Smilacaceae
Smilax auriculata Walter—MF; *D-814, P-1903*
Smilax bona-nox L.—MH; *D-1523, P-1963*
Smilax laurifolia L.—HH; *D-928*
Smilax pumila Walter—XH; *D-1054*
Smilax tamnoides L.—HH; *D-1072*

Typhaceae
Typha domingensis Pers.—FTM, FL; *D-1835, P-2016*
Typha latifolia L.—HH; *D-2166*

Xyridaceae
Xyris brevifolia Michx.—RU; *D-1130, P-1907*
Xyris caroliniana Walter—MF; *D-1352*
Xyris elliottii Chapm.—DM; *D-1834, P-1953*
Xyris jupicai Rich—RU; *D-907, P-1975*
Xyris platylepis Chapm.—RU; *D-854*

EUDICOTS

Acanthaceae
Dyschoriste oblongifolia (Michx.) Kuntze—MH; *D-2162*
Justicia angusta (Chapm.) Small—WF; *P-1349*

Adoxaceae
Sambucus nigra L. subsp. *canadensis* (L.) Bolli—FS; *D-1100*
Viburnum obovatum Walter—MH; *D-1826, P-1927*

Altingiaceae
Liquidambar styraciflua L.—WF; *P-2032*

Amaranthaceae
|Alternanthera philoxeroides (Mart.) Griseb.—FM, FL; *D-990, P-2013*
Amaranthus australis (A. Gray) J.D. Sauer—FTM; *D-882, P-2394*
**Amaranthus hybridus* L.—RU; *D-1203, P-1245*
**Chenopodium ambrosioides* L.—RU; *D-1057*
**Gomphrena serrata* L.—RU; *D-1557*
Iresine diffusa Humb. & Bonpl. ex Willd.—RU; *D-1083*

Anacardiaceae
Rhus copallinum L.—MF; *D-753, P-1902*
|Schinus terebinthifolia Raddi—FTS; *D-849, P-1913*
Toxicodendron radicans (L.) Kuntze—FS; *D-1091, P-1795*

Apiaceae
Eryngium aromaticum Baldwin—SF; *D-838, P-2292*
Eryngium baldwinii Spreng.—RU; *D-1046, P-2019*
Oxypolis filiformis (Walter) Britton—BM; *D-921, P-2541*
Ptilimnium capillaceum (Michx.) Raf.—RU; *D-1168, P-1892*

Apocynaceae
Asclepias feayi Chapm. ex A. Gray—SF; *D-787*
Asclepias pedicellata Walter—HH; *D-937*
Asclepias perennis Walter—FS; *D-1228*
**Catharanthus roseus* (L.) G. Don—RU; *P-1985*
Sarcostemma clausum (Jacq.) Roem. & Schult.—FTS; *D-860*

Aquifoliaceae
Ilex ambigua (Michx.) Torr.—XH; *D-840, P-2539*
Ilex cassine L.—HH; *D-934, P-1923*
Ilex glabra (L.) A. Gray—MF; *D-1084, P-1895*

Araliaceae
Centella asiatica (L.) Urb.—RU; *D-821, P-1965*
Hydrocotyle umbellata L.—RU; *D-1112, P-2115*
Hydrocotyle verticillata Thunb.—BS, HH; *D-1732, P-1965*

Asteraceae
Ageratina jucunda (Greene) Clewell & Wooten—SF; *D-1062*
Ambrosia artemisiifolia L.—RU; *D-2152, P-1286*
Baccharis angustifolia Michx.—FM; *D-998, P-1947*
Baccharis glomeruliflora Pers.—HH; *D-1088, P-1817*
Baccharis halimifolia L.—MaH, RU; *D-1014, P-2378*
Balduina angustifolia (Pursh) B.L. Rob—XH, SC; *D-1578, P-1947*
Bidens alba (L.) DC.—RU; *D-1029, P-1849*
Bidens mitis (Michx.) Sherff—DM; *D-1216*
Bigelowia nudata (Michx.) DC. subsp. *australis* L. C. Anderson—DM; *D-1081, P-2532*
Boltonia diffusa Elliott—BM, WF; *D-950, P-1430*
Carphephorus corymbosus (Nutt.) Torr. & A. Gray—SF, SC; *D-1542, P-1495*
Carphephorus odoratissimus (J.F. Gmel.) H. Hebert var. *subtropicanus* (DeLaney et al.) Wunderlin & B.F. Hansen—MF; *D-964*
**Centratherum punctatum* Cass.—RU; *D-772*
Chrysopsis scabrella Torr. & A. Gray—SC; *D-830, P-2420*
Cirsium horridulum Michx.—RU; *D-1833*
Cirsium nuttallii DC.—RU; *P-1909*
Conoclinium coelestinum (L.) DC.—HH; *D-981*
Conyza canadensis (L.) Cronquist—RU; *D-1028*
Coreopsis leavenworthii Torr. & A. Gray—RU; *D-1051, P-1961*
**Crassocephalum crepidioides* (Benth.) S. Moore—RU; *D-842*
**Cyanthillium cinereum* Blume—FS; *D-1740*
Eclipta prostrata (L.) L.—FM; *D-1003*
Elephantopus elatus Bertol.—MF; *D-902*
**Emilia fosbergii* Nicolson—RU; *D-1030*
**Emilia sonchifolia* (L.) DC.—RU; *D-1095*
Erechtites hieraciifolius (L.) Raf. ex DC.—HH; *D-1094, P-1934*
Erigeron quercifolius Poir.—RU; *D-1171*
Erigeron vernus (L.) Torr. & A. Gray—MF; *D-895*
Eupatorium capillifolium (Lam.) Small ex Porter & Britton—RU; *D-1032, P-2527*
Eupatorium leptophyllum DC.—DM, WF; *D-1586, P-2386*
Eupatorium mohrii Greene—DM, WF; *D-1296, P-1904*
Eupatorium rotundifolium L.—WF; *D-775*
Eupatorium serotinum Michx.—FM; *D-796*
Euthamia caroliniana (L.) Greene ex Porter & Britton—RU; *D-1082, P-2409*
Euthamia graminifolia (L.) Nutt.—HH, WF; *D-1089, P-2526*
Flaveria floridana J.R. Johnst.—TM; *P-2463*
Gamochaeta antillana (Urb.) Anderb.—MH; *D-1182*
Gamochaeta pensylvanica (Willd.) Cabrera—RU; *D-1157, P-1851*
Helianthus agrestis Pollard—HH; *D-1520*
Helianthus angustifolius L.—HH, WF; *D-1526, P-2383*
Helenium amarum (Raf.) H. Rock—RU; *P-1418*
Hieracium megacephalon Nash—SF; *D-1079, P-1938*
Heterotheca subaxillaris (Lam.) Britton & Rusby—RU; *P-1263*

Iva microcephala Nutt.—HH; *D-910*
Lactuca graminifolia Michx.—RU; *P-1244*
Liatris tenufiolia Nutt. var. *quadriflora* Chapm.—SF, SC; *D-837, P-2424*
Lygodesmia aphylla (Nutt.) DC.—MF; *D-936, P-1289*
Mikania cordifolia (L. f.) Willd.—MaH, WF; *D-1010, P-2466*
Mikania scandens (L.) Willd.—HH; *D-1068, P-2537*
Oclemena reticulata (Pursh) G.L. Nesom—WF; *D-2140*
Packera glabella (Poir.) C. Jeffrey—FTM; *D-1177*
Palafoxia feayi A. Gray—SC; *P-2423*
Palafoxia integrifolia (Nutt.) Torr. A. Gray—XH; *D-894*
**Parthenium hysterophorus* L.—RU; *D-811*
Pectis prostrata Cav.—RU; *D-1567*
Phoebanthus grandiflorus (Torr. & A. Gray) S. F. Blake—SF; *D-2278*
Pityopsis graminfolia (Michx.) Nutt.—SC; *D-1038*
Pluchea baccharis (Mill.) Pruski—WF; *D-2148, P-1346*
Pluchea foetida (L.) DC.—BM; *D-922*
Pluchea odorata (L.) Cass.—FTS, HH; *D-966, P-1915*
Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt—XH; *D-1739*
Pterocaulon pycnostachyum (Michx.) Elliott—MF; *D-1525, P-1266*
Sericocarpus tortifolius (Michx.) Nees—MF; *D-979, P-2551*
Solidago fistulosa Mill.—BM, WF; *D-923, P-2380*
Solidago odora Aiton var. *chapmanii* (A. Gray) Cronquist—MF, SC; *D-939, P-2295*
Solidago sempervirens L.—FTM; *D-1005*
Solidago stricta Aiton—MF, TM; *D-853, P-2396*
Solidago tortifolia Elliott—XH; *D-1825*
**Sonchus asper* (L.) Hill—RU; *D-1146*
**Sonchus oleraceus* L.—RU; *P-1936*
[II]*Sphagneticola triloba* (L.) Pruski—RU; *D-776*
Symphyotrichum bahamense (Britton) G.L. Nesom—FM; *D-1092*
Symphyotrichum carolinianum (Walter) Wunderlin & B.F. Hansen—FS; *D-978*
Symphyotrichum dumosum (L.) G.L. Nesom—MF; *D-1085, P-2542*
Verbesina virginica L.—MH; *D-1070*
Vernonia blodgettii Small—HH; *D-792*
Vernonia gigantea (Walter) Trel. ex Branner & Coville—MaH; *D-870*

Avicenniaceae
Avicennia germinans (L.) L.—TS; *P-1866*

Bignoniaceae
Campsis radicans (L.) Seem.—FTS; *D-1159*

Brassicaceae
Cardamine pensylvanica Muhl. ex Willd.—BS; *D-1573*
Lepidium virginicum L.—RU; *D-1170, P-1883*

Cactaceae
Opuntia humifusa (Raf.) Raf.—XH, SC; *D-751, P-1406*
Opuntia stricta (Haw.) Haw.—MaH; *D-1743*

Campanulaceae
Campanula floridana S. Watson ex A. Gray—RU; *D-1172*
Lobelia feayana A. Gray—RU; *D-1173, P-2021*

Caricaceae
**Carica papaya* L.—CHH; *P-2494*

Caryophyllaceae
Drymaria cordata (L.) Willd. ex Schult.—MaH; *D-879*
Stipulicida setacea Michx. var. *lacerata* C.W. James—XH; *D-771, P-1250*

Chrysobalanaceae
Licania michauxii Prance—SF; *D-762, P-1252*

Cistaceae
Helianthemum corymbosum Michx.—SF; *D-1044, P-2010*
Helianthemum nashii Britton—SC; *P-2008*
Lechea divaricata Shuttlew. ex Britton—SC; *P-1335*
Lechea torreyi (Chapm.) Legg. ex Britton—SF; *D-1047, P-2456*

Clusiaceae
Hypericum cistifolium Lam.— *D-900, P-1971*
Hypericum fasciculatum Lam.—DM; *D-760, P-1988*
Hypericum hypericoides (L.) Crantz—MH; *D-1527, P-1972*
Hypericum mutilum L.—RU; *D-1167, P-1992*
Hypericum myrtifolium Lam.—DM, WF; *D-1363, P-1290*
Hypericum tenuifolium Pursh—SF; *D-847, P-1336*
Hypericum tetrapetalum Lam.—MF; *D-1354, P-1897*
Triadenum virginicum (L.) Raf.—DM; *D-2279*

Combretaceae
Conocarpus erectus L.—TS; *P-1857*
Laguncularia racemosa (L.) C. F. Gaertn.—FTS, TS; *D-856, P-1853*

Convolvulaceae
Cuscuta obtusiflora Kunth var. *glandulosa* Engelm.—FS; *D-1097*
Dichondra carolinensis Michx.—MH; *D-1558*
Ipomoea alba L.—FS; *D-1026*
Ipomoea cordatotriloba Dennst.—RU; *D-1067*
**Ipomoea quamoclit* L.—RU; *D-1551*
Ipomoea sagittata Poir.—FTS; *D-878*
**Ipomoea triloba* L.—RU; *P-2411*

Cornaceae
Cornus foemina Mill.—HH; *D-1076, P-1910*
Nyssa sylvatica Marshall var. *biflora* (Walter) Sarg.—FS; *D-1832*

Cucurbitaceae
Melothria pendula L.—HH; *D-1518*
**Momordica charantia* L.—HH; *D-945, P-2524*

Droseraceae
Drosera capillaris Poir.—BM; *D-1180, P-1991*

Ebenaceae
Diospyros virginiana L.—DM, RU; *D-1195, P-1982*

Ericaceae
Bejaria racemosa Vent.—SF; *D-758, P-1269*
Gaylussacia dumosa (Andrews) Torr. & A. Gray—XH; *D-1234, P-1946*
Lyonia fruticosa (Michx.) G. S. Torr.—SF; *D-1514, P-1797*
Lyonia lucida (Lam.) K. Koch—MF; *D-1156, P-1804*
Vaccinium arboreum Marshall—MaH, SC; *D-874, P-2001*
Vaccinium corymbosum L.—MF; *D-1140*
Vaccinium darrowii Camp—MF; *D-1185, P-1274*
Vaccinium myrsinites Lam.—XH, SC; *D-1579, P-1799*
Vaccinium stamineum L.—MF, SC; *D-1184, P-1999*

Euphorbiaceae
Acalypha gracilens A. Gray—RU; *D-1511, P-2410*
Chamaesyce blodgetii (Engelm. ex Hitchc.) Small—RU; *D-1560, P-1287*
Chamaesyce hirta (L.) Millsp.—RU; *D-1562, P-2024*
Chamaesyce hypericifolia (L.) Millsp.—RU; *D-960*
Cnidoscolus stimulosus (Michx.) Engelm. & A. Gray—SF; *D-1189*
Croton glandulosus L. var. *septentrionalis* Müll. Arg.—RU; *D-2281*
Euphorbia polyphylla Engelm. ex Chapm.—SF; *D-2151, P-1248*
Poinsettia cyathophora (Murray) Bartling—RU; *P-1242*
[I]*Sapium sebiferum* (L.) Roxb.—RU; *P-1240*
Stillingia sylvatica L.—MF; *D-2133, P-1901*

Fabaceae
[I]*Abrus precatorius* L.—RU; *D-1545*
Aeschonymene americana L.—HH; *D-1559*
**Alysicarpus ovalifolius* (Schumach. & Thonn.) J. Léonard—RU; *P-1504*
Amorpha fruticosa L.—HH; *D-985, P-1926*

Apios americana Medik.—HH; *D-825*
Canavalia rosea (Sw.) DC.—FTS, CHH; *D-1008, P-1847*
Chamaecrista fasciculata (Michx.) Greene—XH; *D-2155, P-2294*
Chamaecrista nictitans (L.) Moench var. *nictitans*—RU; *D-916*
Chamaecrista nictitans (L.) Moench var. *aspera* (Muhl. ex Elliott) H.S. Irwin & Barneby—RU; *D-959, P-2287*
Chapmannia floridana Torr. & A. Gray—SF; *D-786, P-1241*
**Crotalaria lanceolata* E. Mey.—RU; *D-779*
**Crotalaria pallida* Aiton var. *obovata* (G. Don) Polhill—RU; *D-1353, P-2384*
Crotalaria rotundifolia J. F. Gmel.—RU; *D-1107, P-2039*
Dalbergia ecastaphyllum (L.) Taub.—FTS, TS; *D-861, P-1856*
Dalea carnea (Michx.) Poir.—MF; *D-941*
Dalea pinnata (J.F. Gmel.) Barneby var. *adenopoda* (Rydb.) Barneby—SC; *P-2531*
**Desmodium incanum* DC.—RU; *D-1510*
Desmodium paniculatum (L.) DC.—FS; *D-970, P-2399*
**Desmodium tortuosum* (Sw.) DC.—RU; *D-826*
**Desmodium triflorum* (L.) DC.—RU; *D-1215*
**Enterolobium contortisiliquum* (Vell.) Morong—RU; *P-1937*
Erythrina herbacea L.—CHH; *D-1722, P-1854*
Galactia elliottii Nutt.—MF; *D-1000, P-1896*
Galactia regularis (L.) Britton et al.—MaH; *D-868*
Galactia volubilis (L.) Britton—SF; *D-1218*
**Indigofera hirsuta* L.—RU; *D-963, P-2382*
Lupinus diffusus Nutt.—SC; *P-2421*
**Macroptilium lathyroides* (L.) Urb.—RU; *D-788, P-2031*
**Medicago lupulina* L.—RU; *D-1144*
Mimosa quadrivalvis L. var. *angustata* (Torr. & A. Gray) Barneby—XH; *P-1268*
Mimosa strigillosa—RU; *P-2017*
**Senna alata* (L.) Roxb.—RU; *D-1027, P-1251*
Senna ligustrina (L.) H.S. Irwin & Barneby—MH; *D-1522*
**Senna obtusifolia* (L.) H.S. Irwin & Barneby—RU; *D-1553*
Sesbania herbacea (Mill.) McVaugh—RU; *D-899, P-2288*
[II]*Sesbania punicea* (Cav.) Benth.—FTS; *D-1020*
Sesbania vesicaria (Jacq.) Elliott—WF; *P-2432*
Tephrosia spicata (Walter) Torr. & A. Gray—SF; *D-2134*
Vicia acutifolia Elliott—RU; *D-1143*
Vicia floridana S. Watson—FM; *D-1176*
Vigna luteola (Jacq.) Benth.—HH; *D-869, P-2286*

Fagaceae
Quercus chapmanii Sarg.—SF; *D-1546, P-1813*
Quercus geminata Small—XH; *D-1544,P-1945*
Quercus laevis Walter—SC; *P-1253*
Quercus laurifolia Michx.—HH; *D-1120, P-1922*
Quercus minima (Sarg.) Small—SF, MF; *D-815, P-1894*
Quercus myrtifolia Willd.—XH; *D-752, P-1402*
Quercus nigra L.—MH; *D-1524, P-1939*
Quercus pumila Walter—SF; *D-770, P-2480*
Quercus virginiana Mill.—MaH, MH; *D-872, P-1929*

Gelsemiaceae
Gelsemium sempervirens (L.) Aiton f.—MaH, XH; *D-1841, P-1798*

Gentianaceae
Sabatia brevifolia Raf.—WF; *D-896, P-1503*
Sabatia calycina (Lam.) A. Heller—FTM; *D-1023*
Sabatia grandiflora (A. Gray) Small—DM; *D-1361*

Geraniaceae
Geranium carolinianum L.—RU; *D-1205*

Haloragaceae
Proserpinaca palustris L.—HH; *P-2477*
Proserpinaca pectinata Lam.—BM, DM; *D-925, P-1255*

Iteaceae
Itea virginica L.—FS; *D-1004*

Juglandaceae
Carya aquatica (F. Michx.) Nutt.—FTS; *D-1160*

Lamiaceae
Callicarpa americana L.—MH, HH; *D-961, P-1914*
**Clerodendrum indicum* (L.) Kuntze—MH; *D-1119*
Hyptis alata (Raf.) Shinners—MH; *D-953, P-2474*
**Hyptis pectinata* (L.) Poit.—MH; *D-1064*
**Hyptis verticillata* Jacq.—MH; *D-1033*
Physostegia leptophylla Small—FTM; *D-1174*
Piloblephis rigida (W. Bartram ex Benth.) Raf.—SF; *D-1127, P-1795*
Scutellaria integrifolia L.—MaH; *D-1011, P-1890*
Trichostema dichotomum—SC; *P-2416*

Lentibulariaceae
Utricularia cornuta Michx.—DM; *D-1125*
Utricularia foliosa L.—BM; *D-930*
Utricularia gibba L.—DM; *D-799*
Utricularia juncea Vahl—DM; *P-2303*
Utricularia purpurea Walter—BM; *D-927, P-1501*
Utricularia subulata L.—DM; *D-2141, P-1806*

Lythraceae
Ammannia latifolia L. —FTS, CHH; *D-999, P-2464*
**Cuphea carthagenensis* (Jacq.) J.F. Macbr.—RU; *P-1246*
Lythrum alatum Pursh. var. *lanceolatum* (Elliott) Torr. & A. Gray ex Rothr.—RU; *D-898*
Lytrhum lineare L.—FTM; *D-1018, P-2462*

Malvaceae
Hibiscus grandiflorus Michx.—HH; *D-1521*
Kosteletzkya pentacarpos (L.) Ledeb.—FTS; *D-885*
**Melochia corchorifolia* L.—RU; *D-952*
Sida rhombifolia L.—RU; *D-1364*
[II]*Urena lobata* L.—MH; *D-957, P-2468*

Menyanthaceae
Nymphoides aquatica (J.F. Gmel.) Kuntze—BM; *D-931, P-2033*

Melastomataceae
Rhexia mariana L.—RU; *D-901, P-2473*
Rhexia nuttallii C.W. James—WF; *D-2137*

Molluginaceae
**Mollugo verticillata* L.—RU; *D-1222*

Moraceae
Ficus aurea Nutt.—FTS, CHH; *D-1726, P-1846*
Morus rubra L.—FS; *D-845*

Myricaceae
Myrica cerifera L.—FS, SC; *D-1096, P-1800*

Myrsinaceae
Ardisia escallonioides Schiede & Deppe ex Schltdl.—MaH; *D-1840*
Myrsine cubana A. DC.—MaH; *D-864, P-1921*

Myrtaceae
**Eucalyptus camaldulensis* Dehnh. subsp. *acuta* Brooker & M.W. McDonald—MF, *P-1502*
Eugenia axillaris (Sw.) Willd.—FTS; *D-1724*
[I]*Eugenia uniflora* L.—HH; *P-1917*
[I]*Melaleuca quiquenervia* (Cav.) S.T. Blake—HH; *P-2550*
[I]*Psidium cattleianum* Sabine—HH; *P-2487*
[I]*Rhodomyrtus tomentosa* (Aiton) Hassk.—WF; *P-2036*

Olacaceae
Ximenia americana L.—MH; *D-757*

Oleaceae
Fraxinus caroliniana Mill.—FS; *D-966*

Onagraceae
Gaura angustifolia Michx.—RU; *D-1209, P-1885*
Ludwigia arcuata Walter—DM; *D-1217, P-1294*
Ludwigia curtissii Chapm.—TM; *P-2486*
Ludwigia leptocarpa (Nutt.) H. Hara—RU; *P-2377*
Ludwigia linifolia Poir.—BM, DM; *D-932, P-2291*
Ludwigia maritima R.M. Harper—MF, RU; *D-2138, P-2425*
Ludwigia octovalvis (Jacq.) P.H. Raven—*D-908, P-1933*
Ludwigia palustris (L.) Elliott—FM, BS; *D-949, P-2444*
[I]*Ludwigia peruviana* (L.) H. Hara—FS; *D-969*
Ludwigia repens J.R. Forst.—HH; *D-1093*
Ludwigia suffruticosa Walter—DM; *D-1358, P-1293*
Oenothera laciniata Hill—RU; *D-1198, P-2020*

Orobanchaceae
Agalinis fasciculata (Elliott) Raf.—RU; *D-1512*
Agalinis filifolia (Nutt.) Raf.—SC; *P-2422*
Buchnera americana L.—RU; *D-1110, P-1884*

Oxalidaceae
Oxalis corniculata L.—MH; *D-1073, P-1973*

Petiveriaceae
Rivina humilis L.—MH; *D-1069*

Phyllanthaceae
**Phyllanthus tenellus* Roxb.—RU; *D-1519*
**Phyllanthus urinaria* L.—MH; *D-1031, P-2470*

Phytolaccaceae
Phytolacca americana L.—RU; *D-1594, P-1417*

Plantaginaceae
Bacopa caroliniana (Walter) B. L. Rob.—BM; *P-2490*
Bacopa innominata (M. Gómez) Alain—RU; *D-909*
Bacopa monnieri (L.) Pennell—FTM; *D-881, P-1852*
Gratiola hispida (Benth ex. Lindl.) Pollard—SF, SC; *D-1355, P-1337*
Gratiola pilosa Michx.—WF; *P-2458*
Gratiola ramosa Walter—WF; *D-1186*
Linaria canadensis (L.) Chaz.—RU; *D-1142, P-1891*
**Lindernia crustacea* (L.) F. Muell.—RU; *D-822, P-1416*
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperr.—RU; *D-1200, P-2022*
Lindernia grandiflora Nutt.—HH; *D-1060, P-2491*
Micranthemum glomeratum (Chapm.) Shinners—RU; *D-1199*
Micranthemum umbrosum (J.F. Gmel.) S.F. Blake—BS; *D-1049, P-2443*
Penstemon multiflorus (Benth.) Chapm. ex Small—MH; *D-764*
Plantago virginica L.—RU; *D-1208*
Scoparia dulcis L.—RU; *D-1058, P-1886*

Polygalaceae
Polygala cymosa Walter—DM; *D-2144*
Polygala lutea L.—MF; *P-1949*
Polygala nana (Michx.) DC.—MF; *D-1126, P-1905*
Polygala rugelii Shuttlew. ex Chapm.—WF; *D-2149, P-1291*
Polygala setacea Michx.—MF; *D-935, P-1288*
Polygala violacea Aubl.—RU; *P-2023*

Polygonaceae
Polygonella polygama (Vent.) Engelm. & A. Gray var. *brachystachya* (Meisn.) Wunderlin—SF; *D-774, P-1340*
Polygonum hydropiperoides Michx.—HH; *D-913, P-1968*
Polygonum punctatum Elliott—DM; *D-1541*
Rumex hastatulus Baldwin—RU; *D-1820, P-1899*
Rumex verticillatus L.—FM; *D-1139*

Portulacaceae
**Portulaca amilis* Speg.—RU; *D-1220*
Portulaca oleracea L.—RU; *P-2521*
Portulaca pilosa L.—RU; *D-1219, P-2026*

Primulaceae
Anagallis minima (L.) E.H.L. Krause—RU; *P-1932*

Ranunculaceae
Clematis crispa L.—FS; *D-971*

Rhizophoraceae
Rhizophora mangle L.—FTS, TS; *D-859, P-1865*

Rosaceae
Rubus cuneifolius Pursh—MH; *D-1155, P-2469*
Rubus pensylvanicus Poir.— FS, WF; *D-1148, P-1906*
Rubus trivialis Michx.—RU; *D-1145, P-1803*

Rubiaceae
Cephalanthus occidentalis L.—HH; *D-1297, P-2448*
Chiococca alba (L.) Hitchc.—MaH; *D-865*
Diodia teres Walter—RU; *D-763*
Diodia virginiana L.—RU; *D-1565, P-2472*
Galium tinctorium L.— FL; *P-2014*
Houstonia procumbens (J.F. Gmel.) Standl—SF; *D-1113*
**Oldenlandia corymbosa* L.—RU; *D-965, P-2025*
Oldenlandia uniflora L.—RU; *D-958, P-1931*
Psychotria nervosa Sw.—HH; *D-962*
Psychotria sulzneri Small—MH; *D-1065*
Randia aculeata L.—MaH; *D-863, P-1848*
**Richardia brasiliensis* Gomes—RU; *D-1233, P-2018*
Spermacoce remota Lam.—RU; *D-1507*
**Spermacoce verticillata* L.—RU; *D-1515, P-2484*

Rutaceae
**Citrus ×aurantium* L.—MH; *D-1121*
Zanthoxylum fagara (L.) Sarg.—MaH; *D-871*

Salicaceae
Salix caroliniana Michx.—HH; *D-1154, P-1805*

Samolaceae
Samolus valerandi L. subsp. *parviflorus* (Raf.) Hultén—HH; *D-980, P-1816*

Sapindaceae
Acer rubrum L.—BM, WF; *D-1114, P-1943*

Solanaceae
Lycium carolinianum Walter—FTM; *P-1791*
Physalis angulata L.—RU; *P-2381*
Physalis pubescens L.—RU; *P-2038*
Physalis walteri Nutt.—CHH; *P-1844*
Solanum americanum Mill.—RU; *P-1850*
Solanum chenopodioides Lam.—RU; *P-1845*
[II]*Solanum diphyllum* L.—MH; *D-1118*
[I]*Solanum viarum* Dunal—RU; *D-1552*

Styracaceae
Styrax americanus Lam.—HH; *D-1153*

Tetrachondraceae
Polypremum procumbens L.—RU; *D-749, P-1339*

Theaceae
Gordonia lasianthus (L.) J. Ellis—BG; *D-1582*

Ulmaceae
Ulmus americana L.—FS; *D-1150*

Urticaceae
Boehmeria cylindrica (L.) Sw.—FM; *D-1101, P-1969*

**Pouzolzia zeylanica* (L.) Benn.—RU; *D-819*

Verbenaceae
[1]*Lantana camara* L.—RU; *D-1601*
Phyla nodiflora (L.) Greene—RU; *D-1201, P-1959*

Violaceae
Viola lanceolata L.—MH ; *P-1818*
Viola primulifolia L.—MH; *D-1129*

Viscaceae
Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst.—FS; *D-1163*

Vitaceae
Ampelopsis arborea (L.) Koehne—FS, HH; *D-1539, P-1920*
Parthenocissus quinquefolia (L.) Planch.—MH; *D-1831, P-1919*
Vitis aestivalis Michx.—HH; *D-984*
Vitis rotundifolia Michx.—XH; *D-1223*
Vitis shuttleworthii House—HH; *D-1190*

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BOOK REVIEW

MARY S.G. LINCOLN. 2008. **Liverworts of New England: A Guide for the Amateur Naturalist.** (ISSN: 0077-8931, ISBN-10: 0-89327-478-X, ISBN-13: 978-089327-478-8, hbk., printed on FSC certified 86 lb. gsm glossy). Memoirs of the New York Botanical Garden, Volume 99:1–161. The New York Botanical Garden Press, 200th Street and Kazimiroff Boulevard, Bronx, New York 10458-5126, U.S.A. (**Orders:** 718-817-8721, 718-817-8842 fax, nybgpress@nybg.org). $45.00, 161 pp., more than 105 color images, 200 b/w line drawings, 200 distribution maps, glossary, index, 7" × 10".

Liverworts because of their small size and specialized habitats mostly go unseen but this book should help beginners locate these fascinating life forms in the New England states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut. Early topical sections introduce the reader to liverwort habitats, distribution, morphology, anatomy, life cycle, terminology, and identification. The main body of the text is organized by thalloid liverworts with A. Elevated Receptacles; B. Buried Capsules; C. Simple thalloids; then the Leafy Liverworts D. with Feathery Leaves; E. Toothed Leaves and Incubous Insertion; F. Lobed Leaves and Incubous Insertion; G. with Entire Leaves and Incubous Insertion; H. with toothed leaves and Succubous Insertion; I. with Lobed Leaves and Succubous Insertion; J. with Entire Leaves and Succubous Insertion; K. with Lobed Leaves and Transverse Insertion; L. with Complicate-Bilobed Leaves, Larger Lobe on Top; M. with Complicate-Bilobed Leaves, Small Lobe on Top; N. Leafy-Thalloid Liverworts. Species are arranged into each of these categories and given species descriptions and distribution maps with the green shaded areas representing the known distribution. The maps are helpful in discerning quickly where a given species is found. Here 200 species in 62 genera are described.

Unfortunately too many habit color images lack the magnification, depth of field, and sharp focus to fully interpret the habit and morphological features. Furthermore, no captions are provided to guide the reader to important morphological structures shown, for example, *Ptilidium ciliare* on page 48. The quality of the color images limits the value of this book. There is no key to the species and the keys to the genera at the beginning of each category noted above, A through N, will be difficult to follow since the color images generally lack sufficient detail to illustrate key characters. The line drawings for the Illustrated Key to Hornworts and Liverworts are an additional source of information but are greatly reduced in size to fit on two pages. This book will give a general overview of the diversity, form, and beauty of liverworts for someone who encounters liverworts for the first time.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

DISCOVERY OF *RHYNCHOSIA PRECATORIA* (FABACEAE) IN EVERGLADES NATIONAL PARK, FLORIDA, U.S.A.

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ABSTRACT

The discovery of *Rhynchosia precatoria* DC in the eastern United States is reported. The population found in Everglades National Park, Miami-Dade County, Florida, represents a new addition to the flora of Florida and only the second report for the continental United States.

RESUMEN

El descubrimiento de *Rhynchosia precatoria* DC. en el este de Estados Unidos se reporta. La población se encuentra en el Parque Nacional de Everglades, el Condado de Miami-Dade, Florida, representa una nueva adición a la flora de la Florida.

While surveying for rare plants under a cooperative agreement between The Institute for Regional Conservation and the National Park Service as part of the Critical Ecosystem Studies Initiative (CESI), a species of *Rhynchosia* was verified to be *Rhynchosia precatoria* by Woodmansee and Sadle, who first observed it in February 2002 while visiting a rockland hammock on Long Pine Key, Everglades National Park. In addition to several seedlings, a large plant in flower was observed growing into the forest canopy. Plants were observed again by Woodmansee, Sadle, and National Park Service biologist Jonathan Taylor the following summer, but the plants were sterile. Woodmansee and Sadle observed plants at this station again in October 2003, as well as in an additional rockland hammock 2 km away. A partial fertile specimen was collected in February 2004 in the second hammock and identified as *Rhynchosia precatoria*. Within the two hammocks adult plants number approximately 20 individuals with more than 100 seedlings. The species appears to be well established at both sites based on the presence of multiple life stages and scattered distribution. After Hurricanes Katrina and Wilma, this species proliferated at one of the sites in areas where the forest canopy was damaged by one of the storms. Plants appear to persist in a seedling stage until a gap in the canopy is created. When this occurs, plants grow rapidly to the canopy level and begin to produce flowers and fruit.

Of the *Rhynchosia* species found in Florida (Wunderlin & Hansen 2003), *R. precatoria* (especially young plants) most closely resembles *Rhynchosia swartzii* (Vail) Urban. In Florida, *R. swartzii* is a rare species in light gaps of rockland hammocks in Miami-Dade County and the Florida Keys (Gann et al. 2002). Both *Rhynchosia* species have similarly shaped rhombic to ovate leaves possessing yellow glands. The essential distinguishing characteristic between the two is that *R. precatoria* seeds are distal to the point of funicular attachment, whereas *R. swartzii* seeds are central or sub-central. Additional differences occur in that *R. precatoria* leaflets are larger than 6 cm long and that it is a liana growing to 10 m high in the canopy. It is a vine with a flattened woody stem measuring to over 3 cm wide, and has seeds that are both red and black. *Rhynchosia swartzii* leaves are less than 6 cm long, grows to only a few meters in length, its stem is less than 1 cm wide, and it has seeds that are entirely red (Correll & Correll 1982; Grear 1978).

Rhynchosia precatoria is also very similar to *R. phaseoloides*, a species found in the Caribbean, South America and Southern Panama (Grear 1978). *Rhynchosia precatoria* lacks stipels, has flowers with pedicel length of 1–3mm and corolla length of 8–12mm while *R. phaseoloides* has setiform stipels and flowers with pedicels length of 0.5–1mm and corolla length of 7–8mm. Measurements of the original collection and a

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subsequent collection indicate that the Florida plants are consistent with *R. precatoria* as described by Grear (1978).

Rhynchosia precatoria is also reported for extreme southern Arizona, the only other location in the continental United States (USDA, NRCS 2011). This species is reportedly cultivated in the United States (Grear 1978) and seeds are available for sale on the Internet. Cultivated plants of *R. precatoria* in South Florida are not known to the authors. It seems to be a relatively recent arrival to Florida, however, because it was not reported throughout the years, despite extensive exploration in this region by botanists including John Kunkel Small, Frank C. Craighead Sr., Lloyd L. Loope, and George N. Avery. The location of the two populations is fairly remote and within Everglades National Park, so it is conceivable that this species arrived on its own by natural means. South Florida has many elements in the flora with largely tropical distributions. However, virtually all of the tropical species have at least one occurrence in the West Indies, which *R. precatoria* does not. Obvious human impacts at both sites are relatively limited and the flora is dominated by native plant species. Brazilian-pepper (*Schinus terebinthifolius*), which is found in nearly all hammocks of Everglades National Park, is the primary invasive species found at the site where *R. precatoria* was discovered. Based on a lack of clear evidence to indicate the likely means of arrival of this species in Florida, the nativity of this species is considered by the authors to be unknown.

Voucher specimen: **FLORIDA. Miami-Dade Co.:** Everglades National Park, Long Pine Key, Palma Vista #2 Hammock, occasional in rockland hammock, vining 4 m or more into the canopy within light gaps of tree falls, flowers yellow, seeds red and black, EVER-672, collected with Everglades National Park permit # EVER-2003-SCI-0084, it is presumed native, 10 Feb 2004, *Woodmansee 1366* (FTG).

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NOTEWORTHY VASCULAR PLANT COLLECTIONS FROM CALCASIEU PARISH, LOUISIANA

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ABSTRACT

The publication of vascular flora surveys of Calcasieu Parish, Louisiana by Neyland et al. in 2000 and by Neyland in 2002 and 2009 are updated and revised. Subsequent fieldwork has yielded the discovery of 30 new species records for the parish. *Dichanthelium wrightianum* is reported for Louisiana for the first time. Rare in Louisiana, *Bouteloua curtipendula* var. *curtipendula* and *Zephyranthes chlorosolen* are also reported. A single correction from the original survey is noted.

RESUMEN

La publicación de estudios de la flora vascular de Calcasieu Parish, Louisiana por Neyland et al. en el año 2000 y por Neyland en 2002 y 2009 se actualizó y revisó. Tras el trabajo de campo ha resultado el descubrimiento de 30 nuevos registros de especies para la parroquia. *Dichanthelium wrightianum* se cita de Luisiana por primera vez. Raras en Louisiana, *Bouteloua curtipendula* var. *curtipendula* y *Zephyranthes chlorosolen* se informa. Se señaló una única corrección del estudio original.

INTRODUCTION

This paper updates and revises the original vascular plant surveys by Neyland et al. (2000) and Neyland (2002, 2009). Specifically, the purpose of this paper is to list new collections from Calcasieu Parish and to correct a previous identification error. Detailed information is given for five noteworthy collections included in this survey.

METHODS

Since the publication of the previously mentioned surveys, plant collections from Calcasieu Parish have continued. These collections also include those discovered during the survey of Persimmon Gulley sponsored by the Nature Conservancy. Voucher specimens were prepared using standard herbarium practices and are housed in the McNeese State University (MCN), Louisiana State University (LSU), Arkansas Natural Heritage Commission (ANHC), University of North Carolina (NCU), University of Texas at Austin (UTL-XX), University of Wisconsin-Stevens Point (UWSP) and Vanderbilt (VDB) herbaria. Parish records are listed alphabetically by family. Scientific names follow Flora of North America Committee (1997+) or USDA, NRCS (2010).

RESULTS AND DISCUSSION

The following are new additions to the vascular flora of Calcasieu Parish. These taxa have not been confirmed previously as occurring in the parish. Specimen references below follow the same format as in the original survey (Neyland et al. 2000) and in the subsequent updates (Neyland 2002, 2009). Following the collection data is an abbreviation for the vegetative region where each species typically occurs: pineland (**Pi**); prairie (**Pr**); disturbed sites (**D**); fresh marsh (**FM**); brackish marsh (**BM**).

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Amaranthaceae

Amaranthus australis (A. Gray) Sauer (MCN) *Neyland 2435* D, FM, BM

Amaryllidaceae

Zephyranthes chlorosolen (Herbert) D. Dietrich (MCN) *Neyland 2334* D, Pr

Asteraceae

Chromolaena ivifolia (L.) King & H. Rob (ANHC, LSU) *Reid 7272* Pr
Coreopsis gladiata Walter (LSU) *Rosen w/Reid 5141* Pi
Euthamia caroliniana (L.) Greene ex Porter and Britton (LSU) *Reid* 7774 Pr
Solidago ludoviciana (A. Gray) Small (LSU) *Reid* 7776 Pr
Symphyotrichum ontarionis (Weig.) Nesom (LSU) *Reid* 7772 Pr

Clusiaceae

Hypericum fasciculatum Lam. (LSU) *Rosen* w/*Reid 5094* Pi

Cyperaceae

Carex longii Mack. (LSU) *Reid 7394* Pr
Carex meadii Dewey (BRIT, LSU, MO, TEX) *Rosen* w/*Reid 5181* Pi
Eleocharis tenuis Schult. var. *verrucosa* (Svens.) (LSU) *Reid* 6545 Pr
Fimbristylis dichotoma (L.) Vahl (LSU, VDB) *Reid 7687* Pr
Rhynchospora careyana Fernald (LSU, TEX) *Rosen* w/*Reid 5121* Pi
Rhynchospora globularis (Chapm.) Small var. *pinetorum* (B.S.P.) Gale (LSU, VDB) *Reid* 6548 Pr
Rhynchospora rariflora (Michx.) Elliott (LSU) *Reid 7081* Pr
Rhynchospora recognita (Gale) Kral (LSU) *Reid 7462* Pi, Pr
Scleria muehlenbergii Steud. (LSU) *Reid 7665* Pr
Scleria paucifolia Muhl. Ex Willd. (LSU) *Reid* 6538 Pr

Fabaceae

Desmodium sessilifolium (Torr.) Torr. & A. Gray (LSU) *Reid 7668* Pr
Strophostyles leiosperma (Torr. & A. Gray) Piper (LSU) *Reid 7673* Pr

Hypoxidaceae

Hypoxis rigida Chapm. (LSU, TEX, MO) *Rosen* w/*Reid* 5185 Pi

Lamiaceae

Monarda citriodora Cerv. ex Lag. ssp. *citriodora* (MCN) *Neyland 2432* D
Scutellaria parvula Michx. var. *missouriensis* (Torr.) Goodman & C.A. Lawson LSU *Rosen* 5118 Pi

Poaceae

Bouteloua curtipendula (Michx.) Torr. var. *curtipendula* (LSU, NCU, TEX-LL) *Reid* w/ *Rosen 7541* D
Dichanthelium consanguineum (Kunth) Gould & C.A. Clark (UWSP) *Reid* w/ *Rosen* 7537 Pi
Dichanthelium wrightianum (Scribn.) Freckmann (LSU) *Reid* w/ *Rosen 7628* Pi
Panicum tenerum Beyr. Ex Trin. (LSU, TEX, MO) *Rosen* w/*Reid* 5093 Pi
Paspalum modestum Mez (LSU) *Reid* 7677 Pr
Sacciolepis indica (L.) Chase (LSU, NCU) *Reid* 7670 Pr

Scrophulariaceae

Gratiola neglecta Torr. (LSU, TEX) *Rosen* w/*Reid* 5225 Pi

The following entry was misidentified in the original survey (Neyland et al. 2000). The specimen reported as *Amaranthus cannabinus* (L.) Sauer *Neyland 1003* **BM, FM,** is *Amaranthus australis* (A. Gray) Sauer. Therefore, this misidentified taxon is removed from the survey. As a result of these revisions to the three previous vascular surveys, the number of confirmed specific and subspecific entries for the parish is increased to 1203.

Four of the above collections are noteworthy. First, *Zephyranthes chlorosolen* is listed as S2 (imperiled) in Louisiana by the Louisiana Natural Heritage Program (2010). The listed specimen represents a fairly large population from along railroad tracks that run through a coastal prairie remnant in Lake Charles. The only other known population in Calcasieu Parish was discovered in 2005 (Reid, 5621, LSU) along the same railroad line in a coastal prairie remnant near Vinton, LA. The distance between these two populations is approximately 33km.

Second, *Bouteloua curtipendula* (Michx.) Torr. var. *curtipendula* is listed as S1 (critically imperiled) in Louisiana (NatureServe 2010). Native populations occur on calcareous prairies in Louisiana (Allen et al. 2004). The specimen cited above was collected from a large well-established population on a dry rocky roadside and is an apparent introduction.

Third, *Dichanthelium wrightianum* is reported as new to Louisiana. In the southeastern United States, this wet pine savanna grass ranges from Virginia to Texas but is not included in Louisiana (Freckmann & Lelong 2003; Allen et al. 2003; Diggs et al. 2006).

Fourth, *Monarda citriodora* Cerv. ex Lag. ssp. *citriodora* was collected along railroad tracks near the AMTRACK station in Lake Charles. The collected specimen represents the sole individual observed. This species has been collected in the northern half and the southeastern portion of Louisiana. However, this is the first collection of this species from the southwestern portion of the state. It is uncertain whether this is a waif or represents a prairie remnant.

Additionally, in the Neyland et al. 2000 paper, *Tillandsia recurvata* (L.) L. (Neyland, 1846, MCN) was listed in the Calcasieu flora. This specimen was collected from a recently introduced population. However, a specimen was collected in 2010 (Neyland, 2436, MCN) that represents what may be a natural population. The specimen was collected in an ancient *Quercus virginiana* tree near the Calcasieu River in Lake Charles. This and an adjacent *Q. virginiana* tree were both heavily infested with *T. recurvata*. Based on this information, Harry

Luther (pers. comm.) stated that this population is most likely derived from native Texas stock. Whether this is a natural or a very old introduced population remains uncertain.

ACKNOWLEDGMENTS

We greatly appreciate the review comments of Michael MacRoberts.

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BOOK REVIEW

David Carle. 2010. **Introduction to Earth, Soil, and Land in California.** (ISBN 978-0-520-26681-0, pbk.). California Natural History Guides 101. University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu, 510-642-9737). $19.95, 230 pp., 101 color illustrations, 11 line illustrations, 18 maps, 2 tables, 4½" × 7¼".

This book follows David Carle's previous natural history guides to air, fire, and water, and is an exploration into yet another primary element of the natural world, the land beneath our feet. His goal is to educate and encourage all Californians to appreciate the living soil as the fundamental basis for life and to become better stewards of this valuable resource.

Introduction to Earth, Soil, and Land in California begins with the story of ecosystems beneath the surface of the earth. It introduces the processes and communities of organisms that build and replenish soil. The book then leads to broader topics with a comprehensive overview of humans on the land, turning land into real estate, population growth, wildlife management, and farmland. Discussion of untamed land is filled with interesting geological information on earthquakes, volcanoes, and landslides. Carle's guide is filled with relevant facts and is told in a narrative style that makes a subject, which to some might seem boring, quite interesting. While not being technically difficult to read, the material is covered in great detail and Carle carefully breaks down the various issues. We feel the passion that Carle feels for preserving our environment. It would be difficult not to have a greater sense of appreciation for the soil beneath our feet after having read his book.

The book is written from a perspective more political and historical rather than technical, and includes numerous wonderful color photographs, maps, and other illustrations. Also included in the back of the book is an Index, extensive list of Online Soil and Land Resources, References, and Art Credits.—*Doty Bucy, Master Gardener and volunteer, Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A.*

ADDITIONAL OBSERVATIONS OF THE ASSOCIATED PLANT SPECIES SURROUNDING POPULATIONS OF *CYPRIPEDIUM KENTUCKIENSE* (ORCHIDACEAE) IN WEST CENTRAL LOUISIANA

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ABSTRACT

The vegetation surrounding 23 groups of *Cypripedium kentuckiense* Reed in west central Louisiana was sampled using nearest individuals and the dominant species within a five meter radius area. Twenty-two of the study sites are located on the Fort Polk Military Installation in Vernon Parish, Louisiana and an additional sample was on the nearby Kisatchie National Forest in Natchitoches Parish. The most common associated herbaceous species was *Chasmanthium sessiliflorum*, woody vine *Toxicodendron radicans*, shrub/sapling *Hamamelis virginiana*, small tree *Ilex opaca*, and big tree *Quercus alba*.

RESUMEN

La vegetación que rodea a 23 grupos de *Cypripedium kentuckiense* Reed en el centro oeste de Louisiana se muestrearon usando el individuo más próximo y la especie dominante en un área de cinco metros de radio. Veintidós de los lugares de estudio están localizados en la instalación militar de Fort Polk en la parroquia de Vernon, Louisiana y una muestra adicional estaba en el vecino Kisatchie National Forest en la parroquia de Natchitoches. Las especies herbáceas asociadas más comunes fueron *Chasmanthium sessiliflorum*, trepadora leñosa *Toxicodendron radicans*, arbusto/árbol joven *Hamamelis virginiana*, árbol pequeño *Ilex opaca*, y árbol grande *Quercus alba*.

INTRODUCTION

In a previous paper, the vegetation around five populations of *Cyprepidium kentuckiense* Reed at Fort Polk, Louisiana was reported (Allen et al. 2004). As pointed out then, this was the first report of quantitative data on the vegetation associated with *C. kentuckiense*. In this paper we report on the vegetation associated with 23 populations in west central Louisiana including the five populations included in the first report (Allen et al. 2004). *Cyprepidium kentuckiense* is a rare south-eastern orchid of global conservation concern (G3) (NatureServe 2010). The habitat in Louisiana and east Texas is reported to be mesophytic wood, calcareous forest, and hardwood slope forest (Louisiana Natural Heritage Program 2003; Poole et al. 2007). In the previous report, *C. kentuckiense* was found to be associated with a forest composed of *Fagus grandifolia*, *Ostrya virginiana*, *Symplocos tinctoria*, *Quercus alba*, and *Hamamelis virginiana* in the overstory and *Toxicodendron radicans* and *Thelypteris hexagonoptera* in the understory. The purpose of this paper is to further characterize the vegetation immediately surrounding *C. kentuckiense* populations. Information on *C. kentuckiense* populations across the southeast and on other qualitative inventories of similar habitat is given in the previous paper and will not be repeated here (Allen et al. 2004).

Cypripedium kentuckiense is a rare orchid with a global conservation status of G3, which is defined as being at moderate risk of extinction due to a restricted range, and relatively few populations (NatureServe 2010). Within the United States, its distribution is limited to the southeastern states of AL, AR, GA, KY, LA, MS, OK, TN, TX, and VA (Flora of North America Editorial Committee 2002). Specifically, in AL, GA, LA, MS, OK, TX, and VA, this orchid is rated S1 - critically imperiled because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state or province (NatureServe 2010). It is rated S2 (imperiled with 20 or fewer) in TN, S1/S2 in Kentucky and S3 (vulnerable with 80 or fewer) in Arkansas. Furthermore, while this range of distribution seems geographically moderate, most individual populations of yellow lady's slipper are relatively small (often consisting of 1–3

plants) (NatureServe 2010). This orchid is reported from 12 counties in east Texas (Diggs et al. 2006; Liggio & Liggio 1999) and in Louisiana, is reported from 11 parishes with four from unverified reports (Louisiana Department of Wildlife and Fisheries; Natural Heritage Program 2003). Due to its rarity, beauty, and the conservational interest of a variety of parties, there have been several reintroduction projects initiated with varied results in the past (US Forest Service 2011; Loos & Philipps 2010).

STUDY SITES AND METHODS

We studied 22 Fort Polk sites located on the banks of Bird's, Liberty, and Ouiska Chitto Creeks and their tributaries on Fort Polk in Vernon Parish and one site located on the banks of a tributary of Kisatchie Bayou in Natchitoches Parish. The soil at the Vernon Parish sites is Eastwood silt loam (Soil Survey Division 2003) and at the Natchitoches Parish site is Malbis fine sandy loam (Soil Survey Division 1990).

All data from the 23 populations of *Cypripedium kentuckiense* were collected during June 2010. During this time period, all of the woody plants and most of the herbaceous ones are identifiable to species. Most of the 23 clumps were composed of 3–5 individual plants, and all plants appeared to be in good health, with some just passing the flowering stage. The area surrounding each of the 23 lady-slipper sites was examined and the five nearest individuals to the center of the clump were identified to species including herbaceous, woody-vines, shrubs (woody non-vine shorter than six feet), shrubs/saplings (woody non-vines taller than six feet and five inch or less dbh), and trees (woody non-vines taller than six feet and larger than five inch dbh). Additionally, the one dominant species within a 5m radius was also recorded for the herbaceous, woody-vines, and shrub category. All raw data collected in the field were entered and calculation of variables performed using Microsoft Excel. At each of the 23 sites, five individual plants were recorded for each of the five vegetation categories producing a total of 115 individuals per category. The relative abundance was calculated by dividing the number of times that a species was recorded by 115, the total number of observations. This was done for all five categories and each value was converted to a percent. The frequency was calculated for each species by dividing the number of sites of occurrence by the total number of sites (23). The relative frequency was calculated by dividing the frequency for a species by the total of all frequencies for the category. For herbaceous, shrubs, and woody-vines, the relative dominance was calculated by dividing the species's number of dominant sites by 23. This value was converted to a percent. Importance values for the herbaceous, woody-vines, and shrubs were calculated by summing the relative abundance, relative frequency, and relative dominance and for the shrubs/saplings and trees by the sum of the relative abundance and relative frequency.

RESULTS AND DISCUSSION

A total of 76 species were recorded including 24 herbaceous, 12 woody-vines, and 40 woody non-vines (31 shrubs, 19 shrubs/saplings and 16 trees note overlap in categories) (Tables 1–5). The species are listed in decreasing importance values. The top three associated herbaceous species are *Chasmanthium sessiliflorum*, *Polystichum acrostichoides*, and *Brachyelytrum erectum* (Table 1). For woody-vines, the most important species is *Toxicodendron radicans* with almost half of the importance value; *Bignonia capreolata* and *Smilax smallii* are second and third respectively (Table 2). The top three species for shrubs are *Hamamelis virginiana*, *Acer rubrum*, and *Styrax grandifolius* (Table 3). For shrubs/saplings, the top three species are *Ilex opaca*, *Fagus grandifolia*, and *Hamamelis virginiana* (Table 4). The three trees with the highest importance value are *Quercus alba*, *Tilia americana*, and *Nyssa sylvatica* (Table 5).

Almost all of the herbaceous species identified in this study were also listed by Allen et al. (2004) and six species overlapped in the top ten important species for each study. Broad beechfern (*Thelypteris hexagonoptera*) was found in association with all of the known National Forest locations in Texas (Loos & Philipps 2010). The woody vine species that dominated (importance value = 123.72) in the Allen et al. (2004) study as well as this study (importance value = 128.28) was *Toxicodendron radicans*. Seven of the shrub/sapling species reported in the top ten in importance value in Allen et al. (2004) were also in the top ten in the shrub and/or shrub/sapling categories in this study. The top five tree species in our study were *Quercus alba*, *Tilia americana*, *Nyssa sylvatica*,

Table 1. List of herbaceous species recorded from 23 *Cypripedium kentuckiense* sites in west central Louisiana.

species	abundance	frequency percent	dominance	importance value
Chasmanthium sessiliflorum	12	52.17	7	51.48
Polystichum acrostichoides	8	34.78	4	28.89
Brachyelytrum erectum	9	39.13	3	26.93
Thelypteris hexagonoptera	14	60.87	2	23.90
Solidago caesia	13	56.52	1	23.23
Scleria oligantha	9	39.13	1	21.26
Dichanthelium commutatum	9	39.13	0	19.95
Desmodium glutinosum	9	39.13	1	19.75
Dichanthelium boscii	5	21.74	2	17.59
Mitchella repens	3	13.04	1	11.50
Phaseolus polystachios	5	21.74	0	10.41
Carex albicans	4	17.39	0	8.02
Cynoglossum virginianum	2	8.70	1	7.60
Elephantopus tomentosus	2	8.70	0	4.77
Dioscorea villosa	2	8.70	0	3.25
Aster lateriflorus	1	4.35	0	2.38
Carex debilis	1	4.35	0	2.38
Melica mutica	1	4.35	0	2.38
Ruellia carolinensis	1	4.35	0	2.38
Salvia lyrata	1	4.35	0	2.38
Sanicula canadensis	1	4.35	0	2.38
Spigelia marilandica	1	4.35	0	2.38
Viola spp.	1	4.35	0	2.38
Viola walterii	1	4.35	0	2.38
Total				300

Table 2. List of woody-vine species recorded from 23 *Cypripedium kentuckiense* sites in west central Louisiana.

species	abundance	frequency percent	dominance	importance value
Toxicodendron radicans	53	60.87	12	123.72
Bignonia capreolata	17	34.78	2	38.02
Smilax smallii	7	21.74	3	28.22
Smilax tamnoides	8	17.39	3	27.27
Smilax pumila	10	26.09	1	23.95
Parthenocissus quinquefolia	7	26.09	1	21.34
Vitis rotundifolia	2	8.70	1	9.72
Smilax glauca	4	13.04	0	8.93
Smilax bona-nox	2	8.70	0	5.38
Smilax rotundifolia	2	8.70	0	5.38
Vitis spp.	2	8.70	0	5.38
Rubus argutus	1	4.35	0	2.69
Total				300

Fagus grandifolia, and *Pinus taeda* while the Allen et al. (2004) study's top five tree species were *Fagus grandifolia*, *Quercus alba*, *Symplocos tinctoria*, *Nyssa sylvatica*, and *Ostrya virginiana*. Some of the lack of overlap between the two studies could be attributed to the use of three woody nonvine categories in this study compared to two in the 2004 study by Allen et al.

The Fort Polk military installation offers a unique and valuable opportunity to conduct ecological research due to the vast areas of restricted, and thus, undisturbed habitat. This study generated a list of associated species for *Cypripedium kentuckiense* based mainly on the Fort Polk populations. These association data should be similar across much of the southern range of the species, especially in Louisiana and east Texas.

TABLE 3. List of shrub species recorded from 23 *Cypripedium kentuckiense* sites in west central Louisiana.

species	abundance	frequency percent	dominance	importance value
Hamamelis virginiana	16	34.78	6	50.53
Acer rubrum	14	34.78	2	31.40
Styrax grandifolius	10	21.74	3	28.32
Symplocos tinctoria	8	13.04	3	23.95
Pinus taeda	7	26.09	1	18.33
Euonymus americanus	9	17.39	1	17.44
Arundinaria gigantea	5	13.04	2	16.99
Fagus grandifolia	6	21.74	1	16.14
Ulmus alata	3	13.04	1	10.90
Tilia americana	2	8.70	1	8.72
Viburnum dentatum	4	13.04	0	7.43
Vaccinium elliottii	3	13.04	0	6.56
Quercus falcata	3	8.70	0	5.24
Acer barbatum	2	8.70	0	4.37
Carya cordiformis	2	8.70	0	4.37
Crataegus spathulata	2	8.70	0	4.37
Ilex opaca	2	8.70	0	4.37
Prunus serotina	2	8.70	0	4.37
Chionanthus virginicus	0	0.00	1	4.35
Vaccinium arboreum	0	0.00	1	4.35
Quercus incana	3	4.35	0	3.92
Fraxinus americana	2	4.35	0	3.05
Sassafras albidum	2	4.35	0	3.05
Callicarpa americana	1	4.35	0	2.19
Carpinus caroliniana	1	4.35	0	2.19
Nyssa sylvatica	1	4.35	0	2.19
Ostrya virginiana	1	4.35	0	2.19
Quercus alba	1	4.35	0	2.19
Quercus shumardii	1	4.35	0	2.19
Rhododendron canescens	1	4.35	0	2.19
Sabal minor	1	4.35	0	2.19
Total				**300**

TABLE 4. List of shrub/sapling species (woody non woody-vines taller than six feet and five inch or less dbh) recorded from 23 *Cypripedium kentuckiense* sites in west central Louisiana.

species	abundance	frequency percent	importance value
Ilex opaca	29	69.57	46.84
Fagus grandifolia	14	39.13	24.34
Hamamelis virginiana	13	34.78	22.12
Symplocos tinctoria	13	26.09	19.41
Ostrya virginiana	10	30.43	18.16
Tilia americana	10	21.74	15.45
Fraxinus americana	6	17.39	10.62
Acer barbatum	4	13.04	7.53
Ulmus alata	3	13.04	6.66
Cornus florida	2	8.70	4.44
Liquidambar styraciflua	2	8.70	4.44
Nyssa sylvatica	2	8.70	4.44
Carpinus caroliniana	1	4.35	2.22
Celtis reticulata	1	4.35	2.22
Ilex longipes	1	4.35	2.22
Magnolia virginiana	1	4.35	2.22
Styrax grandifolius	1	4.35	2.22
Ulmus americana	1	4.35	2.22
Vaccinium arboreum	1	4.35	2.22
Total			**200**

Table 5. List of tree species (woody non woody-vines taller than six feet and larger than five inch dbh) recorded from 23 *Cypripedium kentuckiense* sites in west central Louisiana.

species	abundance	frequency percent	importance value
Quercus alba	14	43.48	25.16
Tilia americana	15	34.78	23.43
Nyssa sylvatica	12	34.78	20.82
Fagus grandifolia	13	30.43	20.40
Pinus taeda	10	34.78	19.09
Liquidambar styraciflua	9	30.43	16.92
Ilex opaca	10	17.39	13.89
Fraxinus americana	8	21.74	13.45
Acer rubrum	6	26.09	13.01
Carya alba	7	17.39	11.28
Acer barbatum	3	13.04	6.50
Ostrya virginiana	2	8.70	4.34
Ulmus americana	2	8.70	4.34
Quercus shumardii	2	4.35	3.04
Carya ovata	1	4.35	2.17
Magnolia grandifolia	1	4.35	2.17
Total			**200**

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BOOK REVIEW

David Deardorff and Kathryn Wadsworth. 2009. **What's Wrong With My Plant? (And How Do I Fix It?): A Visual Guide to Easy Diagnosis and Organic Remedies.** (ISBN 978-0-88192-961-4, pbk.). Timber Press, the Haseltine Building, 133 S.W. Second Avenue, Suite 450, Portland, Oregon 97204-3527, U.S.A. (**Orders:** www.timberpress.com, 800-827-5622). $24.95, 451 pp., 7¾" × 9¼".

What's Wrong With My Plant? (And How Do I Fix It?) A Visual Guide to Easy Diagnosis and Organic Remedies is a book written to assist the layperson's issues with their garden, landscape and house plants, and remedy those issues. The use of color illustrations and photographs help the non-scientist make a diagnosis of almost any plant health issue you may face. David Deardorff is a plant pathologist and botanist, bringing a professional and scientific background, while Kathryn Wadsworth relies on her love of gardening and the outdoors to bring a more personal touch.

The book is broken in to three parts: Part 1 provides easy to follow flow charts designed to help the user determine the issue; Part 2 helps you determine the best (organic) solution; and Part 3 is a photo gallery of all the common problems found in your plants. Part 1 has its chapters organized by whole plant or the individual parts of the plant (leaves, flowers, branches, roots, etc.). Part 2 breaks down in to the individual ailments in each chapter (growing conditions, fungi, insects, nematodes, etc.). Part 3 provides photos for all of the problems you've researched in Parts 1 and 2 and has them organized by plant part again, in the same order and fashion as Part 1. Finally, an appendix titled "What's Wrong With My Lawn" allows you to analyze issues you may be having in your yard. This is a very short section, covering most of the basic premises of lawn care as well as some tips on how to maintain a healthy, but sustainable lawn. The book wraps up with a Resources section, a Glossary, References, and an Index.

The flow charts in this book are very well laid out and work very similar to a dichotomous key. Overall, they make it very easy to determine your problem. Even more helpful are the real photographs in Part 3 of actual cases of problems. They're well done and are typically representative of the problems. I was able to diagnose three different issues I was having on my own property (two in the garden and one in my shrubbery) caused by three different issues. All were correct, and the remedies provided in Part 2 were helpful. My only complaint is that it is an organic-based book, so it doesn't really offer much in terms of chemical treatment for insect and disease issues, but it is what it is. I would highly recommend this book to anyone who takes pride in their landscaping or gardening, professionals and hobbyists alike. Plant care is often a delicate balance, and this book provides many of the tools needed to find that balance.—*Micah Chambers, SWCA Environmental Consultants, 3901 Arlington Highlands Blvd, Suite 200, Arlington, TX 76018, mchambers@swca.com*

A QUANTITATIVE STUDY OF THE VEGETATION SURROUNDING THE *TAENIDIA INTEGERRIMA* (APIACEAE) POPULATION AT FORT POLK IN WEST CENTRAL LOUISIANA

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ABSTRACT

The vegetation surrounding a yellow pimpernel (*Taenidia integerrima*) population on Fort Polk in Vernon Parish in west central Louisiana is reported. This species is rare in Louisiana (S2) and very little habitat data are available for the species throughout its range. The number of species found in the samples totaled forty-seven with eight woody vine species, twenty-two herbaceous species, and seventeen tree or shrub species. The most common associated herbaceous species was *Chasmanthium sessiliflorum*, the most common associated woody vines species was *Toxicodendron radicans*, and the most common associated tree and shrub species was *Hamamelis virginiana*.

RESUMEN

Se estudió la vegetación que rodea una población de pimpinela amarilla (*Taenidia integerrima*) en Fort Polk en Vernon Parish en el centro oeste de Louisiana. Esta especie es rara en Louisiana (S2) y hay muy pocos datos disponibles del hábitat de la especie en todo su rango. El numero de especies encontradas totalizó cuarenta y siete con ocho especies trepadoras leñosas, veintidós herbáceas, y diez y siete árboles o arbustos. La especie herbácea asociada más común fue *Chasmanthium sessiliflorum*, la más común de las lianas leñosas fue *Toxicodendron radicans*, y la especie arbórea y arbustiva más común fue *Hamamelis virginiana*.

INTRODUCTION

Yellow pimpernel, *Taenidia integerrima* (L.) Drude, is an herbaceous perennial member of the Apiaceae that ranges throughout the eastern United States (USDA NRCS 2011). Although globally secure and reported from 32 states, it is found sparingly throughout most of them (NatureServe 2011). However, in the West Gulf Coastal Plain on the western edge of its range, it is rare (S2) being reported in Louisiana from five parishes Bienville, Caldwell, Natchitoches, Vernon and Winn (Louisiana Natural Heritage Program 2011). It is reported from Harrison, Red River, Sabine, and San Augustine Counties in east Texas (Turner et al. 2003) but only from San Augustine County in the USDA database (USDA NRCS 2011).

Taenidia integerrima is usually found on the edges of wooded areas, especially where wooded slopes occur and its habitat includes rocky bluffs along river and creek valleys, relatively dry, open rocky woods where little shrub or herbaceous vegetation occur, and rocky bluffs where the forest canopy is broken (Guthrie 1968). According to NatureServe (2011) it is found in mesic calcareous forests and Britton and Brown (1943) report it from rocky or sandy soils. In Louisiana, Larke and Smith (2003) report the habitat as open hardwood-dominated calcareous forests, often on lower slopes or near small intermittent creeks.

Our study population is located in Vernon Parish in west central Louisiana on the sloped banks of a ravine which feeds into Bird's Creek. The soil at the site is Eastwood silt loam (Soil Survey Division 2003).

METHODS

A 25 × 5m macro plot was positioned over the *Taenidia integerrima* population. The sampled area was divided into 50 (5 × 0.5m) plots and ten plots for sampling were randomly selected using a random number generator. Each plot was systematically examined and all species were identified and the number of plants was determined and recorded. For the herbaceous plants, woody vines, and shrubs/saplings, cover was determined by measuring and adding up the total length-width area (stem and leaves) occupied by the individuals of each

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species in the sample. For trees that were as tall as or taller than 1.9m, the DBH was measured at the standard 1.37m height using a diameter tape and recorded to the nearest 0.1 cm.

All data were entered into Microsoft Excel for storage and calculations of variables. The percent cover was calculated by dividing the area occupied by each species by the plot area ($2.5m^2$), and multiplying by 100. The mean diversity (richness), density (number of plants per plot), and percent cover plus the standard deviation were calculated for the ten plots for each plant group (herbaceous plants, woody vines, shrubs/saplings, and all plants). The mean dbh and standard deviation for the shrubs/trees were calculated for the ten plots. The frequency, mean density, mean cover percent and mean DBH were calculated for each species in all ten plots. The relative values for each of these variables (frequency, mean density, mean DBH, and mean cover percent) were calculated by dividing the value for the species by the total for all species in the plant group. Each value was multiplied by 100 to convert it to percent and the sums of the relative values were used to determine the importance value with a total of 300 for woody vines and herbaceous and 400 for the tree/shrubs.

RESULTS

The number of species totaled forty-seven with eight woody vines, twenty-two herbaceous plants, and seventeen tree, shrub or saplings (Table 1). The mean number of species per plot ranged from 4.40 for woody vines to 9.70 for herbaceous plants. The mean number of plants per plot (density) was 74.20 for all plants and ranged from 8.70 for trees and shrubs to 44.40 for herbaceous plants. The mean cover percent for all plants was 95.67 and ranged from 18.93 percent for woody vines to 55.86 percent for herbaceous plants. The mean dbh per sample was 15.10 cm.

The tree and shrub species are listed in Table 2, the woody vines are listed in Table 3 and the herbaceous species are listed in Table 4. The species are arranged in descending importance value in all of the tables. The three most important tree and shrub species are *Hamamelis virginiana* (69.17), *Tilia americana* (59.02), and *Viburnum dentatum*) (25.94) (Table 2). The most important woody vine species was *Toxicodendron radicans* (76.83), while *Parthenocissus quinquefolia* (75.33) and *Smilax smallii* (39.57) ranked second and third respectively (Table 3). The dominant herbaceous species was *Chasmanthium sessiliflorum* with an importance value of 74.84 followed by *Taenidia integerrima* (42.46) and *Desmodium glutinosum* (39.70) (Table 4).

DISCUSSION

Our community data are similar to the larger nested yellow lady slipper plots on Fort Polk (Allen et al. 2004). They reported seventy-eight total species with nine woody vines, twenty-one herbaceous species, and forty-five tree, shrub or saplings. Their mean number of species per sample ranged from 9.00 for woody vines to 23.80 for shrubs and saplings. The mean number of stems per sample (density) averaged 651.40 per sample for all plants and ranged from 77.00 for trees and shrubs to 216.80 for shrubs and saplings. The mean cover percent for all plants was 240.74 percent and ranged from 8.68 percent for woody vines to 159.86 percent for herbaceous plants. The mean dbh per sample was 877.98 cm.

The Fort Polk/Vernon Parish population is associated with the herbaceous species, *Chasmanthium sessiliflorum* and *Desmodium glutinosum*. The woody vines, *Toxicodendron radicans* and *Parthenocissus quinquifolia* were also found associated with *Taenidia integerrima* at this location. We also found the two most common associated tree and shrub species were *Hamamelis virginiana* and *Tilia americana*. The vegetation surrounding the *Taenidia integerrima* population is similar to nearby lady slipper populations (Megyeri & Allen 2011 and Allen et al. 2004). These authors also found *Hamamelis virginiana* as one of the top three shrubs/saplings and *Tilia americana* as one of the top three trees. For the herbaceous plants, *Chasmanthium sessiliflorum* was associated as one of the top three species along with *Toxicodendron radicans* and *Smilax smalii* as two out of the top three species in woody vines.

Our data are the first quantitative report on the vegetation surrounding *Taenidia integerrima*. The vegetation around the other populations of *Taenidia integerrima* throughout its range should be sampled for comparison with our data so as to get a better idea of the variation, if any, of its habitat.

TABLE 1. Communnity variables for ten sample plots around the *Taenidia integerrima* population on Fort Polk in West Central Louisiana.

	Diversity (Richness)				
	All Plants	Herbaceous Plants	Trees/ Shrubs	Woody Vines	
Mean	17.70	9.70	4.70	4.40	
Std Dev.	4.30	2.31	1.83	1.26	
Range	12–21	5–13	2–8	2–7	
Total Number	47	22	17	8	
	Density (Number of plants per plot)				
	All Plants	Herbaceous Plants	Trees/ Shrubs	Woody Vines	
Mean	74.20	44.40	8.70	21.10	
Std Dev.	21.33	10.96	3.65	13.00	
Range	50–114	26–60	5–12	7–46	
	Cover Percent				DBH (cm)
	All Plants	Herbaceous Plants	Shrubs/ Saplings	Woody Vines	Trees/ Shrubs
Mean	95.67	55.86	22.88	18.93	15.10
Std Dev.	29.33	11.54	20.65	4.56	20.65
Range	53.17–166.59	41.49–75.94	6.69–71.23	4.39–41.50	26–37

TABLE 2. Variables for Tree/Shrub species in ten sample plots around the *Taenidia integerrima* population on Fort Polk in West Central Louisiana.

Species	Mean Frequency	Mean Density	Mean Cover	DBH	Importance Value
Hamamelis virginiana	90.00	2.20	5.16	0.00	69.17
Tilia americana	30.00	0.50	2.32	5.40	59.02
Viburnum dentatum	50.00	1.90	5.05	0.00	56.69
Liquidambar styraciflua	20.00	0.20	0.00	7.10	53.57
Acer rubrum	50.00	0.70	2.43	1.75	41.90
Quercus alba	50.00	0.90	1.31	0.00	27.24
Fraxinus americana	40.00	0.50	0.99	0.00	18.99
Styrax grandifolius	10.00	0.30	2.29	0.00	16.54
Ostrya virginiana	30.00	0.30	0.27	0.00	11.11
Cornus florida	10.00	0.10	0.00	0.85	8.91
Vaccinium virgatum	10.00	0.20	0.57	0.00	7.14
Pinus taeda	20.00	0.20	0.04	0.00	6.72
Prunus serotina	20.00	0.20	0.02	0.00	6.63
Ulmus alata	10.00	0.20	0.20	0.00	5.40
Carya ovata	10.00	0.10	0.16	0.00	4.04
Crataegus marshallii	10.00	0.10	0.06	0.00	3.55
Sassafras albidum	10.00	0.10	0.02	0.00	3.37
Total	470.00	8.70	20.88	15.10	400.00

TABLE 3. Variables for Woody Vine species in ten sample plots around the *Taenidia integerrima* population on Fort Polk in West Central Louisiana.

Species	Frequency	Mean Density	Mean Cover	Importance Value
Toxicodendron radicans	90.00	6.10	5.20	76.83
Parthenocissus quinquefolia	60.00	7.00	5.40	75.33
Smilax smallii	70.00	1.90	2.77	39.57
Bignonia capreolata	40.00	3.30	1.84	34.47
Smilax tamnoides	50.00	0.90	1.73	24.78
Smilax glauca	60.00	1.00	0.67	21.90
Vitis spp.	40.00	0.50	0.49	14.03
Smilax rotundifolium	30.00	0.40	0.83	13.10
Total	440.00	21.10	18.93	300.00

TABLE 4. Variables for Herbaceous species in ten sample plots around the Taenidia integerrima population on Fort Polk in West Central Louisiana.

Species	Frequency	Mean Density	Mean Cover	Importance Value
Chasmanthium sessiliflorum	100.00	7.10	27.12	74.84
Taenidia integerrima	80.00	10.70	5.65	42.46
Desmodium glutinosum	90.00	7.60	7.43	39.70
Dichanthelium boscii	100.00	4.30	3.18	25.70
Scleria oligantha	60.00	1.50	2.52	14.08
Elephantopus carolinianus	50.00	1.90	2.40	13.73
Phaseolus polystachios	70.00	1.40	0.75	11.71
Desmodium laevigatum	30.00	2.10	2.04	11.47
Solidago caesia	40.00	2.10	0.94	10.54
Symphyotrichum drummondii	50.00	1.00	0.41	8.13
Dichanthelium comutatum	50.00	0.90	0.50	8.08
Viola walterii	40.00	0.70	0.19	6.04
Mitchella repens	30.00	0.70	0.42	5.42
Scutellaria elliptica	40.00	0.50	0.08	5.40
Polystichum acrostichoides	20.00	0.20	1.42	5.05
Ruellia caroliniensis	30.00	0.60	0.19	4.78
Verbesina virginica	20.00	0.20	0.32	3.09
Symphyotrichum lateriflorum	20.00	0.30	0.15	3.00
Lilium michauxii	20.00	0.20	0.12	2.72
Sanicula canadensis	10.00	0.20	0.02	1.52
Euphorbia corollata	10.00	0.10	0.01	1.27
Salvia lyrata	10.00	0.10	0.01	1.27
Total	970.00	44.40	55.86	300.00

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BOOK NOTICES | BOOKS RECEIVED

STEVE MANNING. FOREWORD BY RUDOLF JENNY. 2010. **Discovering New World Orchids.** (ISBN 978-0-9565594-0-1, hbk.). Steve Manning, 4 The Cedars, Nantwich, Cheshire, CW5 5GZ, UK. (**Orders:** http://www.amazon.com/Discovering-World-Orchids-Steve-Manning/dp/0956559409). $Price not given, 669 pp., color throughout, 8¼" × 11⅝".

A fascinating book about orchid history, orchid collectors, orchid growers, and botanists.

P. BARRY TOMLINSON, JAMES W. HORN, AND JACK B. FISHER. 2011. **The Anatomy of Palms: Arecaceae-Palmae.** (ISBN 978-0-19-955892-6, hbk.). Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, UK. (**Orders:** www.oup.com). $225.00, 251 pp., b/w and color photos, 8½" × 11".

Table of Contents: Introduction to palm structure (Part 1), Systematic anatomy of palms (Part 2), bibliography, Index to scientific names, Index to subject.

From the publisher: The first section (Palm Structure) starts with a description of the often original anatomical techniques used, followed by the principles of palm development, a series of chapters on the microscopic anatomy of all the main organs, and finally an analysis of how these structures might have evolved. The second section (Systematic Anatomy) documents the systematic anatomical variation found in the subfamilies, tribes, and subtribes. The internal structure of all vegetative organs is reviewed, although lamina anatomy is emphasized. Anatomically outstanding genera are described in detail. Art and science ar thus informatively combined.

With the incredible anatomical variation found in palms, the color photos throughout the book are simply stunning and beautiful to look at.

CARLOS G. VELAZCO MACÍAS AND GALFIRO J. ALANÍS FLORES. 2010. **Cactáceae de Nuevo León.** (ISBN 978-607-433-302-2, pbk.). Universidad Autónoma de Nuevo León, Biblioteca universitaria Raúl Rangel Frías, Alfonso Reyes 4000 norte, Quinto Piso, Monterrey, Nuevo León, MEXICO, C.P. 64440. (**Orders:** rciencia@mail.uanl.mx, rciencia@gmail.com). $Price not given, 155 pp., color throughout, 9" × 9".

Table of Contents: Introduction, Anatomy and physiology, Ecology, History and traditional use, Conservation, ¿Qué conocemos de Nuevo León?, Como utilizar esta guia, Clave práctica para identificar los géneros de Nuevo León,, Listado de especies de cactáceae en Nuevo León, Glossary, References, Description of genera and species.

Cactáceae de Nuevo León is a beautiful book.

JORGE G. VILLARRERAL GONZÁLEZ. 2010. **Vida Silvestre de la Cuenca "Palo Blanco," Nuevo León, México.** (ISBN not given, pbk.). Consejo Estatal de Flora y Fauna Silvestre de Nuevo León, A.C.; Parques y Vida Silvestre de Nuevo León, O.P.D.; Universidad Autónoma de Nuevo León, MEXICO, C.P. 64440. (**Orders:** www.cefloravfaunasilvestrenl.org.mx, ceffsnl@prodigy.net.mx). $Price not given, 266 pp., color throughout, 10¾" × 8¾".

AN ANNOTATED CHECKLIST OF THE VASCULAR FLORA OF WASHINGTON COUNTY, MISSISSIPPI

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ABSTRACT

Field explorations have yielded 271 species new to Washington County, Mississippi and *Calandrinia ciliata* (Ruiz & Pav.) DC. and *Ruellia nudiflora* (Engelm. & .A. Gray) Urban new to the state. An annotated list of 809 taxa for Washington County is provided and excludes 59 species that were reported from counties adjacent and included in the 1980 Washington County and environs flora, but have yet to be documented from Washington County.

RESUMEN

Exploraciones de campo han dado como resultado 271 especies nuevas para Washington County, Mississippi y *Calandrinia ciliata* (Ruiz & Pav.) DC. y *Ruellia nudiflora* (Engelm. & .A. Gray) Urban nuevas para el estado. Se aporta una lista anotada de 809 taxa para Washington County y se excluyen 59 especies que estaban citadas de condados adyacentes e incluidas en la flora de 1980 de Washington County y alrededores, pero que no se han documentado aún para Washington County.

INTRODUCTION

The flora of Mississippi, especially the Yazoo-Mississippi River Alluvial Plain, is poorly reported (Bryson & Carter 1994; Skojac et al. 2007) compared to other physiographic regions of Mississippi and of adjacent states. Lowe's Plants of Mississippi (1921) still remains the only effort at a comprehensive flora of the state. Several county floras have been compiled, mostly by graduate students at various universities; however, comprehensive floras are lacking for more than 80% of Mississippi's 82 counties. Gunn et al. (1980) prepared a Flora of Washington County and Environs. This work has been the standard for plant identification by researchers, consultants, educators, farmers, and the general public for the past quarter century. Gunn et al. (1980) listed 669 taxa for Washington County and environs; however, 131 species were collected in the adjacent counties of Bolivar, Humphreys, Issaquena, Sharkey, and Sunflower. Because supplies of Gunn et al. (1980) were depleted almost a decade ago and collection efforts have yielded additional species to the county, our objective is to provide an updated list of the species found only within the confines of Washington County, Mississippi.

Washington County is in the Mississippi-Yazoo alluvial plain of the physiographic or land use area known as the Delta Region (Lowe 1921). The county is bordered by the Mississippi River on the west and lies about half way between Memphis, TN and Vicksburg, MS (Lowe 1921; Skojac et al. 2007). The county is about 20,000 ha and the elevation ranges from 27.5 to 43 m above sea level. Thus, the topography of the region is relatively flat except along the natural and man-made levees of creeks, streams, oxbow lakes, and the Mississippi River. Little of the county remains undisturbed. Most of the land was cleared for row crop production, especially the well-drained areas, and many areas have been under cultivation since the mid 19th century.

Soils of Washington County are deep and fertile and of alluvial origin, and range from poorly drained fine clays to well drained silt loams and sands (Morris 1961). The five main soil associations found in Washington County are nearly level and range from poorly, moderately, and excessively drained. These soil associations occur in areas that are classified as alluvial, slack-water, low terraces, old natural levees and recent natural levees. Over one third of the soils in the county are highly productive sandy loams (e.g., Dundee & Bosket soils)

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and have been historically used for cotton production. Recently, the crop diversity on these soils includes corn, cotton, and soybean, while silt and clay soils are primarily utilized for rice and soybean production, farm raised catfish ponds, or scattered remnant forests. The native mixed deciduous bottomland forest is a product of edaphic rather than climatic conditions (Gunn 1980).

The climate of Washington County is considered temperate with average temperatures ranging from 8°C in January to 24°C in July. The summers are hot and humid with daytime temperatures occasionally over 38°C. During short cold periods in the winter, temperatures are rarely below -10°C. The average growing season is about 200 days with an average killing frost on November 2 and the last hard freeze usually occurs in early to mid March.

Vouchers for the additions to the Washington County flora are deposited in herbaria at the USDA-ARS Jamie Whitten Delta States Research Center (SWSL) and the USDA Southern Hardwoods Research Laboratory (CBHRL) both at Stoneville, MS as indicated in Table 1. Duplicates of many of these collections were distributed to other herbaria within Mississippi (DSC, IBE, MISS, MISSA, MMNS, or USMS) and elsewhere depending on the number of duplicates. Collector, collection number, and herbarium or a publication that reported additional species to Washington County are cited following each species added since Gunn et al. (1980).

RESULTS AND DISCUSSION

As a result of fieldwork during the past three decades, 271 species have been added to the flora of Washington County, Mississippi. *Calandrinia ciliata* (Ruiz & Pav.) DC. and *Ruellia nudiflora* (Engelm. & A. Gray) Urban, both new to the state, are reported in the annotated flora of Washington County (Table 1). Since Gunn et al. (1980), 72 species listed from adjacent counties were collected within the county; 59 species have not been detected yet in Washington County and are listed in Table 2. A few species were misidentified (e.g., the voucher for *Sida elliottii* Torr. & A. Gray was an abberant specimen of S. *rhombifolia* L.), and thus not included in the annotated list for Washington County (Table 1) but retained in those species yet to be collected within the county (Table 2). Nomenclature changes since Gunn et al. (1980) were updated to follow published volumes of Flora of North America, e.g., *Urochloa ramosa* (L.) R.D. Webster for *Brachiaria ramosa* (L.) Stapf. Other taxa were redetermined or aligned with currently accepted nomenclature or where species concepts have changed, such as *Carex aureolensis* Steud. rather than *C. frankii* Kunth, now defined as taxa with a distribution well north of the Delta Region. Alignment of families not yet treated yet in Flora of North America follow Missouri Botanical Garden's Tropicos (Tropicos 2011). Author abbreviations follow The International Plant Names Index (IPNI 2011). With these additions and realignments as mentioned above, 809 taxa are now known within the bounds of Washington County.

Of the 117 Family cited as occuring in Washington County and environs by Gunn et al. (1980), one family, one family, Asclepiadaceae, was lumped into Apocynaceae (Table 1), and Melastomataceae, was excluded because no species within the family were found within the confines of Washington County (Table 2). Eleven families were added to the flora of Washington County and include Annonaceae, Berberidaceae, Dioscoreaceae, Cannabaceae, Fumariaceae, Haloragaceae, Hippocastanaceae, Lygodiaceae, Simaroubaceae, Sterculiaceae, and Thelypteridaceae (Table 1). Fumariaceae was included in Gunn et al. (based on a collection of *Corydalis flavula* (Raf.) DC. from an adjacent county and was included based on a recent collection. Other family names provided by Gunn et al. (1980) were changed to conform to new classification schemes, e.g., Dryopteridaceae for Asplidiaceae; Amaryllidaceae folded into Liliaceae; and Smilaceae segregated from Liliaceae. Ultimately, 122 plant families are listed for Washington County (Table 1).

Additional field research should add native taxa to this list. Also, species not native to the Delta Region will undoubtedly be added because of human activities and the vast areas under cultivation.

TABLE 1. Annotated list of the species collected within Washington County, Mississippi cited in Gunn et al. (1980) or confirmed as noted by literature citation or as new data (collector, collection number, and herbaria where vouchers are deposited).

PTERIDOFITAS

Aspleniaceae
Asplenium platyneuron (L.) Britton, Sterns & Poggenb.

Azollaceae
Azolla caroliniana Willd.

Dryopteridaceae
Athyrium filix-femina (L.) Roth. var. *asplenioides* (Michx.) Hulten
Onoclea sensibilis L.

Equisetaceae
Equisetum hyemale L.

Lygodiaceae
Lygodium japonicum (Thunb.) Sw. (Bryson 16767, SWSL)

Marsileaceae
Marsilea vestita Hook. & Grev.

Ophioglossaceae
Botrychium virginianum (L.) Sw. (Skojac 454, CBHRL)
Ophioglossum vulgatum L var. *pycnostichum* (Fernald) Love & Love (Carter et al. 1990)

Polypodiaceae
Pleopeltis polypoides (L.) Watt

Thelypteridaceae
Thelypteris kunthii (Desv.) Morton (Bryson 6945, SWSL)

GYMNOSPERMAS

Cupressaceae
Cupressocyparis x *leylandii* (Dallim. & A.B. Jacks.) Dallim. (Bryson 23774 & Gardiner, SWSL)
Juniperus virginiana L.
Taxodium distichum (L.) Rich.

Ginkgoaceae
Ginkgo biloba L.

Pinaceae
Pinus elliottii Engelm.
Pinus glabra Walter (Bryson23767 & Gardiner, SWSL)
Pinus nigra Aiton (Gunn 11070, SWSL)
Pinus taeda L. (Bryson 23768 & Gardiner, SWSL)
Pinus virginiana Mill. (Bryson 23775 & Gardiner, SWSL)

LILIOPSIDA

Alismataceae
Echinodorus berteroi (Spreng.) Fassett
Echinodorus cordifolius (L.) Griesb.
Sagittaria latifolia Willd. var. *obtusa* (Engel.) B. L. Rob. (Skojac 309, CBHRL)
Sagittaria montevidensis Cham. & Schldtl. var *calycina* (Engelm.) Bogin (Gunn 10363, SWSL)
Sagittaria montevidensis Cham. & Schltdl. subsp. *montevidensis*
Sagittaria platyphylla (Engelm.) J.G. Smith (Bryson 14288 & MacDonald, SWSL)

Araceae
Arisaema dracontium (L.) Schott (Bryson 5720, Morris & Stewart, SWSL)
Arisaema triphyllum (L.) Schott

Arecaceae
Sabal minor (Jacq.) Pers.

Bromeliaceae
Tillandsia usneoides L.

Cannaceae
Canna X *generalis* L. H. Bailey

Commelinaceae
Commelina communis L.
Commelina diffusa Burm. f.
Commelina virginica L.
Murdannia nudiflora (L.) Brenan (Bryson 23762)
Tradescantia ohiensis Raf.
Tradescantia virginiana L.

Cyperaceae
Carex abscondita Mack. (Carter et al. 1990)
Carex albicans Willd. ex Spreng. (Carter et al. 1990, cited as *C. physorhyncha* Liebm. ex Steud.)
Carex annectens E.P. Bicknell
Carex blanda Dewey
Carex bromoides Schkuhr subsp. *bromoides* (Carter et al. 1990)
Carex bulbostylis Mack. (Bryson 11522, SWSL)
Carex caroliniana Schwein. (Bryson 3471, SWSL)
Carex cherokeensis Schwein.
Carex corrugata Fernald (Bryson 3469, SWSL)
Carex crus-corvi Shuttlew. ex Kuntze
Carex decomposita Muhl. (Carter et al. 1990)
Carex festucaceae Schkuhr
Carex flaccosperma Dewey (Bryson 3470, SWSL)
Carex aureolensis Steud. (previously listed as *Carex frankii* Kunth)
Carex hyalina Boott (Bryson et al. 1996)
Carex hyalinolepis Steud.
Carex granularis Muhl. (Bryson 4247, SWSL)
Carex intumescens Rudge (Carter et al. 1990)
Carex leavenworthii Dewey
Carex longii Mack. (Bryson 8373, SWSL)
Carex louisianica L. H. Bailey
Carex lupulina Willd. (Bryson 22322, SWSL)
Carex molesta Mack. (Bryson, Naczi & McDaniel 1992)
Carex oxylepis Torr. & Hook. (Bryson 3616, SWSL)
Carex reniformis (L. H. Bailey) Small (Bryson 4233 & Newton, SWSL)
Carex socialis Mohlenbr. & Schwegman (Bryson 13432, SWSL)
Carex texensis (Torr.) L. H. Bailey (Bryson 4116, SWSL)
Carex triangularis Boeck.
Carex tribuloides Wahl.
Carex typhina Michx.
Carex vulpinoidea Michx.
Cyperus acuminatus Torr. & Hook.
Cyperus compressus L. (Bryson 6605, SWSL)
Cyperus croceus Vahl (Bryson 4046, SWSL)
Cyperus entrerianus Boeck. (Bryson 19877, SWSL)
Cyperus erythrorhizos Muhl.
Cyperus esculentus L.
Cyperus fuscus L. (Bryson & Carter 2008)
Cyperus involucratus Rottb. (Bryson 23038, SWSL)
Cyperus iria L.
Cyperus odoratus L. (Bryson 4629, SWSL)
Cyperus psuedovegetus Steud.
Cyperus retrorsus Chapm. (Bryson 20348)
Cyperus retroflexus Buckley (Bryson & Carter 1992)
Cyperus rotundus L.
Cyperus squarrosa L. (Barnes 1002, SWSL)
Cyperus strigosus L.
Cyperus surinamensis Rottb. (Bryson 20349)

Cyperus uniflorus Torr. & Hook. (Bryson 10430, SWSL)
Cyperus virens Michx. (Gunn 10637, SWSL)
Eleocharis macrostachya Britton (Bryson 13435, SWSL)
Eleocharis montevidensis Kunth (Bryson 13430, SWSL)
Eleocharis obtusa (Willd.) Schultes
Fimbristylis autumnalis (L.) Roem. & Schult. (Bryson 7203, SWSL)
Fimbristylis miliacea (L.) Vahl (Bryson 23583 Kwong & Sagliocco, SWSL)
Fimristylis tomentosa Vahl (Bryson 16603, SWSL)
Fimbristylis vahlii (Lam.) Link
Isolepis carinata (Steud.) Gleason (Bryson 7373, SWSL)
Lipocarpha micrantha Vahl (Carter et al. 1990)
Kyllinga brevifolia Rottb. (Bryson & Carter 1992)
Rhynchospora corniculata (Lam.) A. Gray
Scleria oligantha Michx. (Carter et al. 1990)

Dioscoreaceae
Dioscorea villosa L. (Bryson 5709, Morris & Stewart, SWSL)

Hydrocharitaceae
Limnobium spongia (Bosc) Steud.

Iridaceae
Iris fulva Ker-Gawl. (Bryson 7362, SWSL)
Iris germanica L. (Bryson 5158, SWSL)
Iris virginica L.
Sisyrinchium angustifolium Mill. (Saucier 37, SWSL)
Sisyrinchium atlanticum Bickn. (Bryson 5470, SWSL)
Sisyrinchium mucronatum Michx. (Skojac 215, CBHRL)
Sisyrinchium rostulatum E. P. Bicknell (Bryson 23242, SWSL)

Juncaceae
Juncus acuminatus Michx. (Skojac 1310, CBHRL)
Juncus diffusissimus Buckley
Juncus effusus L.
Juncus elliotii Chapm.
Juncus marginatus Rostk.
Juncus tenuis Willd.
Juncus validus Coville (Skojac 700, CBHRL)

Lemnaceae
Spirodela polyrhiza (L.) Schleid.
Spirodela punctata (G. Mey.) Thomp.
Wolffia brasiliensis Wedd.
Wolffia columbiana H. Karst.

Liliaceae
Allium ampeloprasum L.
Allium vineale L.
Asparagus officinalis L. (Bryson 4532, SWSL)
Hymenocallis liriosme (Raf.) Shinners (Elmore & Clarke s.n., SWSL)
Hymenocallis occidentalis (LeConte) Kunth (Bryson 13983, SWSL)
Leucojum aestivum L. (Bryson, 5144, SWSL)
Lycoris radiata (L'Her.) Herb.
Muscari botryoides (L.) P. Mill. (Paul s.n., SWSL)
Narcissus poeticus L. (Bryson 5130, SWSL)
Narcissus pseudo-narcissus L. (Bryson 51327, SWSL)
Nothoscordum bivalve (L.) Britton (Clarke s.n., SWSL)
Ornithogalum umbellatum L. (Elmore s.n., SWSL)

Najadaceae
Najas flexilis Rostk. & W. L. E. Schmidt

Orchidaceae
Spiranthes ovalis Lindl.
Spiranthes vernalis Englm. & A. Gray (Bryson 11786, Allen & Thomas, SWSL)
Tipularia discolor (Pursh) Nutt.

Poaceae
Agrostis hyemalis (Walter) Britton
Aira elegans Willd. ex Kunth
Alopecurus carolinianus Walter
Andropogon glomeratus (Walter) Britton, Sterns & Poppennb.
Andropogon virginicus L.
Aristida oligantha Michx.
Arundinaria gigantea (Walter) Muhl.
Arundo donax L.
Avena sativa L.
Axonopus fissifolius (Raddi) Kuhlm. (Elmore s.n., SWSL)
Bothrichloa ischaemum (L.) Y. Keng (Bryson 14689, SWSL)
Bothriochloa pertusa (L.) Camus (Bryson 5062, SWSL)
Bromus acemosus L.
Bromus arvensis L. (Saucier s.n., SWSL)
Bromus catharticus Vahl
Bromus inermis Leyss. (Stadelbacher s.n., SWSL)
Bromus secalinus L.
Bromus tectorum L. (Elmore s.n., SWSL)
Cenchrus longispinus (Hack.) Fernald
Chasmanthium latifolium (Michx.) Yates
Chloris virgata Sw. (Skojac 1146, SWSL)
Coelorachis cylindrica (Michx.) Nash
Cynodon dactylon (L.) Pers.
Dactylis glomerata L. (Stadlebacher s.n., SWSL)
Dactyloctenium aegyptium (L.) Willd. (Elomore s.n., SWSL)
Dichanthelium acuminatum (Sw.) Gould & C. A. Clark subsp. *lindheimeri* (Nash) Freckmann & Lelong (Bryson 4820 & Morris, SWSL)
Dichanthelium commutatum (Schult.) Gould
Dichanthelium dichotomum (L.) Gould (Bryson 5719, Morris & Stewart, SWSL)
Dichanthelium laxiflorum (L.) Harvill (Bryson 13992 & MacDonald, SWSL)
Dichanthelium polyanthes (Schult.) Mohlenbr. (Saucier 48, SWSL)
Digitaria ischaemum (Schreber) Muhl.
Digitaria sanguinalis (L.) Scopoli
Echinochloa colonum (L.) Link
Echinochloa crus-galli (L.) P. Beauv.
Echinochloa crus-pavonis (Kunth) Schult. var. *macra* (Wiegand) Gould (Bryson 22990, SWSL)
Echinochloa muricata (P. P. Beauv.) Fernald (Bryson 22838, SWSL)
Echinochloa walteri (Pursh) A. Heller
Eleusine indica (L.) Gaertn.
Elymus virginicus L.
Eragrostis cilianensis (All.) Vignolo. ex Janch. (Bryson 4494 & Hastings, SWSL)
Eragrostis hypnoides (Lam.) Britton
Eragrostis japonica (Thunb.) Trin.
Eragrostis mionor Host
Eragrostis pectinacea (Michx.) Nees
Eragrostis pilosa (L.) P. P. Beauv. (Bryson 6595, SWSL)
Eragrostis secundiflora J. J. Presl. var. *oxylepis* (Torr.) S. D. Koch
Eragrostis spectabilis (Pursh) Steud.
Eriochloa acuminata (J. J. Presl.) Kunth
Eriochloa contracta Hitchc.
Glyceria arkansana Fernald
Hordeum pusillum Nutt.
Imperata cylindrica (L.) P. Beauv. (Bryson 23107, SWSL)
Leersia lenticularis Michx.
Leersia oryzoides (L.) Sw.
Leersia virginica Willd.
Leptochloa fusca (L.) Kunth subsp. *fascicularis* (Lam.) N. Snow (Elmore 204, SWSL)
Leptochloa panicea (Retz.) Ohwi subsp. *brachiata* (Steud.) N. Snow

Leptochloa panicoides (J. Presl) Hitchc.
Lolium perenne L.
Lolium perenne L. subsp. *multiflorum* (Lam.) Husnot (Bryson 20600, SWSL)
Muhlenbergia schreberi J. F. Gmel.
Oplismenus hirtellus (L.) P. Beauv. (Skojac et al. 2007)
Oryza sativa L.
Panicum anceps Michx.
Panicum capillare L.
Panicum dichotomiflorum Michx.
Panicum gymnocarpon Elliott (Skojac 1153, CBHRL)
Panicum rigidulum Bosc ex Nees
Paspalum dilatatum Poir.
Paspalum distichum L.
Paspalum notatum Flügge (Elmore & Weisman s.n., SWSL)
Paspalum pubiflorum Rup. ex E. Fourn. (Lydon s.n., SWSL)
Paspalum repens P. J. Bergius
Paspalum setaceum Michx. var. *ciliatifolium* (Michx.) Vasey
Paspalum urvillei Steud. (Elmore s.n., SWSL)
Phalaris caroliniana Walter
Poa annua L.
Poa pratensis L.
Polypogon monspeliensis (L.) Desf. (Bryson 15986, SWSL)
Schedonorus pratensis (Huds.) P. Beauv.
Sclerochloa dura (L.) P. Beauv. (Carter et al. 1990)
Setaria faberi R. A. W. Herrm. (Bryson 8662, SWSL)
Setaria parviflora (Poir.) Kerguélen
Setaria pumila (Poir.) Roem. & Schult.
Setaria viridis (L.) P. Beauv. var. *minor* (Gaudin) Peterm. (Bryson 8658, SWSL)
Sorghum bicolor (L.) Moench
Sorghum halepense (L.) Pers.
Sphenopholis nitida (Biehler) Scribn.
Sphenopholis obtusata (Michx.) Scribn.
Tridens flavus (L.) Hitchc.
Tridens strictus (Nutt.) Nash (Bryson 23764, SWSL)
Tripsacum dactyloides (L.) L.
Triticum aestivum L.
Urochloa arizonica (Scribn. & Merrill) Morrone & Zuloaga
Urochloa platyphylla (Nash) R. D. Webster
Urochloa ramosa (L.) R. D. Webster
Urochloa texana (Buckley) R. D. Webster (Bryson 6906 & Morris, SWSL)
Vulpia myuros (L.) C. C. Gmel. var. *myuros* (Bryson 13438, SWSL)
Vulpia octoflora (Walt.) Rydb.
Zea mays L.
Zizaniopsis miliacea (Michx.) Döll & Asch.
Zoysia matrella (L.) Merr. (Bryson 8750, SWSL)

Pontederiaceae
Eichhornia crassipes (Mart.) Solms (Skojac et al. 2007)
Heteranthera dubia MacMill.
Heteranthera limosa Willd.
Heteranthera reniformis Raiz & Pav. (MacDonald 9160 & Bryson, SWSL)
Pontederia cordata L. (Saucier 169, SWSL)

Smilaceae
Smilax bona-nox L.
Smilax glauca Walter (Bryson 5699, Morris & Stewart, SWSL)
Smilax herbacea L.
Smilax hispida Muhl. (Skojac 934, CBHRL)
Smilax rotundifolia L.
Smilax tamnoides L. (Bryson 6135 & Morris, SWSL)

Typhaceae
Typha angustifolia L. (Skojac et al. 2007)
Typha latifolia L.

MAGNOLIOPSIDA

Acanthaceae
Justicia ovata (Walter) Lindau
Justicia ovata (Walter) Lindau var. *lanceolata* (Chapm.) Small (Bryson 4657, SWSL)
Ruellia carolinensis (Walter) Steud. (Bryson 13990 & MacDonald, SWSL)
Ruellia nudiflora (Engelm. & A. Gray) Urban (Bryson 18784 Coleman & Goodlett, SWSL)
Ruellia strepens L.

Aceraceae
Acer negundo L.
Acer rubrum L. var. *rubrum* (Bryson 4542, SWSL)
Acer rubrum L. var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg.
Acer saccharinum L.

Aizoaceae
Trianthema portulacastrum L.

Amaranthaceae
Alternanthera caracasana Kunth
Alternanthera philoxeroides (Martius) Griseb.
Amaranthus albus L.
Amaranthus hybridus L.
Amaranthus palmeri S. Watson
Amaranthus retroflexus L.
Amaranthus spinosus L.
Amaranthus viridus L.
Amaranthus tuberculatus (Moq.) Sauer (Bryson 23653, SWSL)
Froelichia gracilis (Hook.) Moquin

Anacardiaceae
Rhus glabra L
Toxicodendron radicans (L.) Kuntze

Annonaceae
Asimina triloba (L.) Dunal (Bryson 4837, SWSL)

Apiaceae
Ammoselinum butleri J. M. Coult. & Rose (Bryson & Elmore 1991)
Bowlesia incana Ruiz & Pav. (Skojac et al. 2007)
Chaerophyllum tainturieri Hook. & Arn.
Cyclospermum leptophyllum (Pers.) Sprague ex Britton & P. Wilson
Cynosciadium digitatum DC.
Daucus carota L.
Eryngium hookeri Walp. (Carter et al. 1990)
Hydrocotyle ranunculoides L. f.
Hydrocotyle umbellata L.
Hydrocotyle verticillata Thunb. (Baker s.n., SWSL)
Limnosciadium pinnatum (DC.) Mathias & Constance (MacDonald 8732, SWSL)
Sanicula canadensis L.
Sanicula odorata (Raf.) K. M. Pryer & L. R. Phillippe (Skojac 769, CBHRL)
Spermolepis echinata (Nutt. ex DC.) A. Heller (MacDonald 8568, SWSL)
Torilis arvensis (Huds.) Link
Torilis nodosa (L.) Gaertn.
Trepocarpus aethusae Nutt. ex DC.

Apocynaceae
Amsonia tabernaemontana Walter
Apocynum cannabinum L.
Asclepias perennis Walter
Asclepias purpurascens L. (Carter et al. 1990)
Cynanchum laeve (Michx.) Pers.

Matelea gonocarpos (Walter) Shinners
Trachelospermum difforme (Walter) A. Gray

Aquifoliaceae
Ilex decidua Walter
Ilex opaca Aiton
Ilex vomitoria Aiton (Bryson 5463, SWSL)

Araliaceae
Aralia spinosa L.
Hedera helix L.

Aristolochiaceae
Aristolochia serpentaria L. (Bryson 5800 & Morris, SWSL)

Asteraceae
Achillea millefolium L.
Acmellia oppositifolia (Lam.) R. K. Jansen
Ambrosia artemisiifolia L. var. *elatior* (L.) Descourt.
Ambrosia trifida L. var. *trifida*
Ampelaster carolinianus (Walter) G. L. Nesom(L. H. Bailey s.n., SWSL)
Anthemis cotula L.
Artemisia annua L. (Bryson 4588 & Croom, SWSL)
Artemisia ludoviciana Nutt. subsp. *albula* (Woot.) D. D. Keck
Baccharis halimifolia L.
Bidens aristosa (Michx.) Britton
Bidens bipinnata L.
Bidens discoidea (Torr. & A. Gray) Britton
Bidens laevis (L.) Britt., Sterns & Poggenb. (Bryson 23662 & Goodlett, SWSL)
Boltonia asateroides (L.) L'Hér.
Boltonia diffusa Elliott (Bryson 8277, SWSL)
Chrysopsis pilosa (Nutt.) Shinners
Cichorium intybus L. (Carter et al. 1990)
Cirsium carolinianum (Walter) Fernald & B. G. Schub. (Frick s.n., SWSL)
Cirsium discolor (Muhl. ex Willd.) Spreng.
Cirsium horridulum Michx.
Cirsium virginianum (L.) Michx.
Cirsium vulgare (Savi) Ten.
Conoclinium coelestinum (L.) DC.
Conyza bonariensis (L.) Cronquist
Conyza canadensis (L.) Cronquist
Conyza ramosissima Cronquist
Coreopsis tinctoria Nutt.
Croptilon divaricatum (Nutt.) Raf.
Dracopis amplexicaulis (Vahl) Cass.
Eclipta prostrata (L.) L.
Elephantopus carolinianus Raeusch.
Erechtites hieracifolia (L.) Raf. ex DC. (Wesley s.n., SWSL)
Erigeron annuus (L.) Pers.
Erigeron philadelphicus L.
Erigeron strigosus Muhl. ex Willd.
Eupatorium capillifolium (Lam.) Small
Eupatorium serotinum Michx.
Fleischmannia incarnatum (Walter) King & H. Rob.
Gamochaeta purpureum (L.) Cabrera
Helenium amarum (Raf.) H. Rock
Helianthus annuus L.
Helianthus grosseserratus M. Martens (s. coll., SWSL)
Helianthus hirsutus Raf. (Saucier 13, SWSL)
Helianthus tuberosus L.
Heterotheca camporum (Greene) Shinners (Bryson 7190, SWSL)
Iva annua L.
Krigia caespitosa (Raf.) K. L. Chambers
Lactuca canadensis L.
Lactuca floridana (L.) Gaertn.
Lactuca serriola L.
Matricaria discoidea DC.
Melanthera nivea (L.) Small (Carter et al. 1990)
Mikania scandens (L.) Willd.
Packera glabella (Poir.) C. Jeffrey
Parthenium hysterophorus L.
Pluchea camphorata (L.) DC.
Pyrrhopappus carolinianus (Walter) DC.
Rudbeckia heliopsidis Torr. & A. Gray (Bryson 15538, SWSL)
Rudbeckia hirta L.
Senecio vulgaris L. (Skojac et al. 2007)
Silphium radula Nutt. (Bryson 15934, SWSL)
Smallanthus uvedalius (L.) Mack. ex Small (Bryson 4832 & Morris, SWSL)
Solidago altissima L.
Solidago canadensis L. (Saucier 9, SWSL)
Soliva sessilis Ruiz & Pav.
Sonchus asper (L.) Hill
Sonchus oleraceus L. (Gunn 10617, SWSL)
Symphotrichum subulatum (Michx.) G. L. Nesom (Bryson 7234, SWSL)
Symphotrichum divaricatum (Nutt.) G. L. Nesom
Symphotrichum dumosum (L.) G. L. Nesom
Symphotrichum elliottii (Torr. & A. Gray) G. L. Nesom (Bryson 15675, SWSL)
Symphotrichum lanceolatum (Willd.) G. L. Nesom (Gunn 10943 & 10793, SWSL)
Symphotrichum ontarionis (Wiegand) G. L. Nesom
Symphotrichum pilosum (Willd.) G. L. Nesom
Symphotrichum racemosum (Elliott) G. L. Nesom
Taraxacum laevigatum (Willd.) DC. (Bryson 18250, SWSL)
Taraxacum officinale Wigg.
Verbesina helianthoides Michx.
Vernonia gigantea (Walter) Trel.
Vernonia glauca (L.) Willd. (Bryson 15537, SWSL)
Xanthium strumarium L.
Youngia japonica (L.) DC. (Bryson 15676 & MacDonald, SWSL)

Balsaminaceae
Impatiens capensis Meerb.

Berberidaceae
Nandina domestica Thunb. (Skojac 776, CBHRL)

Betulaceae
Alnus gutinosa (L.) Gaertn. (Lambert s.n., SWLS)
Betula nigra L. (Bryson 4525, SWSL)

Bignoniaceae
Anisostichus capreolata (L.) Bureau (Bryson 5801 & Morris, SWSL)
Campsis radicans (L.) Seem. ex Bureau
Catalpa bignonioides Walter (Bryson 5668 & Morris, SWSL)
Catalpa speciosa (Warder) Wader ex Engelm.

Boraginaceae
Hackelia virginiana (L.) I. M. Johnst.
Heliotropium indicum L.
Heliotropium procumbens Mill.
Myosotis macrosperma Engelm.

Brassicaceae
Brassica juncea (L.) Czern.
Brassica napus L. var. *napus*
Brassica nigra (L.) W. D. J. Koch
Capsella bursa-pastoris (L.) Medik.
Cardamine hirsuta L (Bryson 5106, SWSL)
Draba brachycarpa Nutt. ex Torr. & A. Gray (Bryson 13390, SWSL)
Lepidium austrinum Small (Bryson & Elmore 1991)
Lepidium densiflorum Schrad. (Bryson 15423, SWSL)
Lepidium didymum L.

Lepidium oblongum Small (Bryson 11523, SWSL)
Lepidium virginicum L.
Noebeckia aquatica (Eaton) Greene (Bryson 8863, SWSL)
Rorippa islandica (Oeder) Borbás
Rorippa sessiliflora (Nutt.) Hitchc.
Sibara virginica (L.) Rollins
Sinapis arvensis L. subsp. *arvensis*
Sisymbrium altissimum L. (Coleman s.n., SWSL)
Sisymbrium officinale (L.) Scop.

Callitrichaceae
Callitriche heterophylla Pursh (Bryson 17762, SWSL)
Callitriche terrestris Raf. (Bryson 5472, SWSL)

Campanulaceae
Lobelia cardinalis L. (Bryson 4862, SWSL)
Triodanis biflora (Ruiz & Pav.) Greene (Bryson 5360, SWSL)
Triodanis perfoliata (L.) Nieuwl.

Cannabaceae
Cannabis sativa L. (s. coll.; confirmed DEA other law enforcement agencies)

Capparaceae
Cleome hassleriana Chod.

Caprifoliaceae
Lonicera japonica Thunb.
Lonicera mackii (Rupr.) Herber (Carter et al. 1990)
Lonicera sempervirens L. (Bryson 23773 & Gardiner, SWSL)
Sambucus nigra L. subsp. *canadensis* (L.) R. Bolli
Viburnum rufidulum Raf. (Bryson 5713 Morris & Stewart)

Caryophyllaceae
Cerastium dubium (Bast.) Guépin (Bryson 15723, SWSL)
Cerastium glomeratum Thuill.
Sagina decumbens (Elliott) Torr. & A.Gray
Saponaria officinalis L.
Silene antirrhina L. (Saucier 26, SWSL)
Stellaria media (L.) Vill. (Bryson 5114, SWSL)
Celastraceae
Euonymus japonicus Thunb.

Ceratophyllaceae
Ceratophyllum demersum L.

Chenopodiaceae
Chenopodium album L.
Chenopodium ambrosioides L.
Chenopodium standleyanum Aellen (Bryson,7149, SWSL)
Cycloloma atriplicifolium (Spreng.) J. M. Coult.

Clusiaceae
Hypericum hypericoides (L.) Crantz (Bryson 5705, Morris & Stewart, SWSL)
Hypericum mutilum L.
Hypericum punctatum Lam.

Convolvulaceae
Calystegia sepium R. Br. (Elmore & Wiseman 129, SWSL)
Convolvulus arvensis L.
Cuscuta compacta Juss.
Cuscuta cuspidata Engelm.
Cuscuta gronovii Roem. & Schult.
Dichondra carolinensis Michx. (Bryson 5854, SWSL)
Ipomoea cordatotriloba Dennst.
Ipomoea hederacea (L.) Jacq. var. *hederacea*
Ipomoea hederacea (L.) Jacq. *integriscula* A. Gray
Ipomoea lancunosa L. (Bryson 21155, SWSL)
Ipomoea pandurata (L.) G. Mey.
Ipomoea purpurea (L.) Roth
Ipomoea quamoclit L. (Bryson 5100, SWSL)
Ipomoea turbinata Lag.
Ipomoea wrightii A. Gray
Ipomoea x leucantha Jacq. (Lydon s.n., SWSL)
Jacquemontia tamnifolia (L.) Griesb. (Elmore s.n., SWSL)

Cornaceae
Cornus drummondii C. A. Mey.
Cornus florida L.
Cornus stricta Lam.

Cucurbitaceae
Cayaponia quinqueloba (Raf.) Shinners
Citrullus lanatus (Thunb.) Matsum. & Nakai var. *citroides* (L. H. Bailey) Mansf. (Bryson 10261, SWSL)
Cucumis melo L.
Cucurbita pepo L. var. *ovifera* (L.) Hartz
Cucurbita pepo L. var. *texana* (Scheele) D. Decker (Bryson 12500, SWSL)
Melothria pendula L.
Sicyos angulatus L.

Ebenaceae
Diospyros virginiana L.

Ericaceae
Vaccinium arboreum Marshall (Carter et al. 1990)

Euphorbiaceae
Acalypha gracilens A. Gray
Acalypha ostryifolia Riddell ex J. M. Coult.
Acalypha rhomboidea Raf.
Caperonia castranifolia (L.) St.-Hil. (Elmore 283, SWSL)
Caperonia palustris (L.) St.-Hil. (Skojac et al. 2007)
Chamaesyce humistrata A. Gray
Chamaesyce hyssopifolia (L.) Small
Chamaesyce maculata (L.) Small
Chamaesyce nutans (Lag.) Small (Bryson 7186, SWSL)
Chamaesyce serpens (Kunth) Small (McDaniel 26446, SWSL)
Croton capitatus Michx.
Croton glandulosa L. var. *septentrionalis* Müll.
Croton monanthogynus Michx. (Bryson 8352, SWSL)
Croton willdenowii G. L. Webster
Euphorbia dentata Michx.
Euphorbia heterophylla L. (Gasperini 23, SWSL)
Phyllanthus urinaria L. (Bryson 8272, SWSL)
Ricinus communis L.
Triadica sebifera (L.) Small

Fabaceae
Albizia julibrissin Durazz.
Amorpha fruticosa L.
Arachis hypogaea L.
Canavalia ensiformis (L.) DC. (Bryson 7235, SWSL)
Cercis canadensis L.
Chamaecrista fasciculata (Michx.) Greene
Clitoria mariana L. (Gunn 11050, SWSL)
Crotalaria spectabilis Roth (Bryson 15560, SWSL)
Desmanthus illinoensis (Michx.) MacMill. ex B. L. Rob. & Fernald
Desmodium canescens (L.) DC.
Desmodium glabellum (Michx.) DC.
Desmodium laevigatum (Nutt.) DC. (Gunn 10680, SWSL)
Desmodium paniculatum (L.) DC.
Desmodium tortuosum (Sw.) DC.
Dioclea multiflora (Torr. & A. Gray) C. Mohr (Bryson 23759, SWSL)
Gleditsia aquatica Marsh.
Gleditsia triacanthos L.

Glycine max (L.) Merr.
Kummerowia striata (Thunb.) Hook. & Arn.
Lathyrus aphaca L.
Lathyrus hirsutus L.
Medicago arabica (L.) Huds.
Medicago lupulina L.
Medicago orbicularis (L.) Bartal. (Stadelbacher s.n., SWSL)
Medicago polymorpha L.
Medicago sativa L. subsp. *sativa*
Melilotus indicus (L.) All.
Melilotus officinalis (L.) Lam.
Mimosa strigillosa Torr. & A. Gray
Phaseolus lunatus L.
Pisum sativum L. (Stadelbacher s.n., SWSL)
Pueraria lobata (Lour.) Merr. var. *lobata* (Willd.) Naesen & S. Almeila
Robinia pseudoacacia L.
Senna alata (L.) Roxb. (Bryson 7222, SWSL)
Senna obtusifolia (L.) Irwin & Barneby
Senna occidentalis (L.) Link
Senna torta (L.) Roxb.
Sesbania drummondii (Rydb.) Cory (Carter et al. 1990)
Sesbania harbacea (Mill.) McVaugh
Sesbania punicea (Cav.) Benth. (Jones 173, SWSL)
Sesbania vesicaria (Jacq.) Elliott
Strophostyles helvola (L.) Elliott
Trifolium arvense L.
Trifolium campestre Schreb.
Trifolium dubium Sibth. (Gunn 10517, SWSL)
Trifolium incarnatum L.
Trifolium nigrescens Viv. (Bryson 5651, SWSL)
Trifolium pratense L.
Trifolium repens L.
Trifolium resupinatum L.
Trifolium vesiculosum Savi (Kurtz s.n., SWSL)
Vicia faba L. (Bryson 16177, SWSL)
Vicia sativa L. subsp. *nigra* (L.) Ehrh.
Vicia villosa Roth subsp. *varia* (Host) Corb.
Vigna unguicalata (L.) Walp.
Wisteria frutescens (L.) Poir. (Skojac 571, CBHRL)

Fagaceae
Castanea mollissima Blume (Bryson 7356, SWSL)
Quercus acutissima Carruth. (Bryson 4700; SWSL)
Quercus alba L. f.
Quercus bicolor Willd. (Bryson23765 & Gardiner, SWSL)
Quercus coccinea Müenchh.
Quercus falcata Michx.
Quercus imbricata Michx.
Quercus laurifolia Michx.
Quercus lyrata Walter
Quercus michauxii Nutt. (Bryson 5003, SWSL)
Quercus nigra L.
Quercus pagoda Raf. (Bryson 5005 & Newton)
Quercus phellos L. (Bryson 4537; 4645)
Quercus rubra L.
Quercus shumardii Buckley (Bryson 4544; 4564; 5812)
Quercus similis Ashe (Bryson 4996, SWSL)
Quercus texana Buckley (McDaniel 1981 SWSL) [=*Quercus nuttallii* Palmer]
Quercus velutina Lam. (Carter et al. 1990)
Quercus virginiana Mill.

Fumariaceae
Corydalis flavula (Raf.) DC. (Bryson 23276, SWSL)

Geraniaceae
Erodium cicutarium (L.) L'Hér. (Laster s.n., SWSL)
Geranium carolinianum L.
Geranium dissectum L.

Haloragaceae
Proserpinaca palustris L. (Skojac et al. 2007)

Hamamelidaceae
Liquidambar styraciflua L.

Hippocastanaceae
Aesculus pavia L. (McDaniel 24935 & Hayes, SWSL)

Hydrophyllaceae
Hydrolea uniflora Raf.
Nemophila menziesii Hook. & Arn. (Bryson 5646, SWSL)

Juglandaceae
Carya aquatica (Michx. f.) Nutt.
Carya cordiformis (Wang.) K. Koch (Skojac et al. 2007)
Carya glabra (Mill.) Sweet (Bryson 8632, SWSL)
Carya illinoinensis (Wangenh.) K. Koch
Carya ovalis Sarg. (Bryson 8634, SWSL)
Carya ovata (Mill.) K. Koch (Bryson 7357, SWSL)
Juglans nigra L.

Lamiaceae
Ajuga pyramidalis L. (Bryson 5157, SWSL)
Glechoma hederacea L. (Bryson 5213, SWSL)
Lamium amlexicaule L.
Lamium purpureum L.
Lycopus rubellus Moench
Lycopus virginicus L. (Skojac 1018, CBHRL)
Melissa officinalis L. (Bryson 8121, SWSL)
Perilla frutescens (L.) Britton (Bryson 8367, SWSL)
Physostegia virginiana (L.) Benth.
Prunella vulgaris L. (Skojac 461, CBHRL)
Stachys tenuifolia Willd.
Teucrium canadense L.

Lauraceae
Sassafrass albidum (Nutt.) Nees var. *molle* (Raf.) Fernald

Lentibulariaceae
Utricularia gibba L.

Loranthaceae
Phoradendron tomentosum (DC.) Engelm. ex A. Gray (Skojac 340, CBHRL)

Lythraceae
Ammannia coccinea Rottb.
Cuphea carthagenensis (Jacq.) F. J. Macb. (Bryson 10550, SWSL)
Lagerstroemia indica L.
Lythrum alatum Pursh var. *lanceolatum* (Elliott) Torr. & A. Gray ex Rothr.

Magnoliaceae
Liriodendron tulipifera L.
Magnolia grandiflora L.
Magnolia macrophylla Michx. (Bryson23769 & Gardiner, SWSL)
Magnolia virginiana L. (Bryson 13927, SWSL)
Michelia figo (Lour.) Spreng. (Bryson 15784, SWSL)

Malvaceae
Abelmoschus esculentus (L.) Moench
Abutilon theophrastii Medik.
Anoda cristata (L.) Schltdl.
Gossypium hirsutum L.
Hibiscus laevis All.
Hibiscus lasiocarpos Cav.
Hibiscus syriacus L.

Hibiscus trionum L.
Malaviscus arboreus Dill ex Cav. var. *drummondii* (Torr. & A. Gray) Schery
Modiola caroliniana (L.) G. Don
Sida rhombifolia L.
Sida spinosa L.

Martyniaceae
Proboscidea louisianica (Mill.) Thell.

Meliaceae
Melia azedarach L.

Menispermaceae
Cocculus carolinus (L.) DC.
Menispermum canadense L. (Skojac et al. 2007)

Molluginaceae
Mollugo verticillata L.

Moraceae
Broussonetia papyrifera (L.) L'Hér. ex Vent
Fatoua villosa (Thunb.) Nakai (Carter et al. 1990)
Ficus carica L.
Maclura pomifera (Raf.) C.K. Schneid.
Morus alba L.
Morus rubra L.

Myrtaceae
Eucalyptus glaucescens Maiden & Blakely (Bryson 23772 & Gardiner, SWSL)

Najadaceae
Najas flexilis Rostk. & W.L.E. Schmidt (Barnes 8, SWSL)
Najas guadalupensis (Spreng.) Magnus (Schrader s.n., SWSL)

Nyctaginaceae
Boerhavia erecta L.
Mirabilis jalapa L.

Nyssaceae
Nyssa aquatica L.
Nyssa sylvatica Marshall (Bryson23766 & Gardiner, SWSL)

Oleaceae
Forestiera acuminata (Michx.) Poir.
Fraxinus americana L. (Bryson 4864, SWSL)
Fraxinus pennsylvanica Marshall
Fraxinus profunda (Bush) Bush
Ligustrum japonicum Thunb.
Ligustrum lucidum Aiton (Skojac 723, CBHRL)
Ligustrum sinense Lour.

Onagraceae
Gaura mollis James
Ludwigia decurrens Walter
Ludwigia glandulosa Walter
Ludwigia leptocarpa (Nutt.) H. Hara
Ludwigia palustris (L.) Elliott
Ludwigia peploides (Kunth) P.H. Raven var. *glabrescens* (Kuntze) P.H. Raven
Ludwigia repens J.R. Forst (Elmore 259, SWSL)
Oenothera biennis L.
Oenothera laciniata Hill
Oenothera speciosa Nutt.

Oxalidaceae
Oxalis dillenii Jacq.
Oxalis rubra A. St.-Hil.
Oxalis stricta L. (Bryson 4841 & Morris, SWSL)

Passifloraceae
Passiflora incarnata L.
Passiflora lutea L.

Penthoraceae
Penthorum sedoides L.

Phytoloccaceae
Phytolacca americana L.

Plantaginaceae
Plantago aristata Michx.
Plantago heterophylla Nutt.
Plantago lanceolata L. (Bryson 4476 & Hastings, SWSL)
Plantago rugelii Decne.
Plantago virginica L.

Plantanaceae
Platanus occidentalis L.

Polygonaceae
Brunnichia ovata (Walter) Shinners
Polygonum aviculare L.
Polygonum cespitosum Blume var. *longisetum* (Bruijn) A. N. Steward
Polygonum erectum L. (Bryson 8114, SWSL)
Polygonum glabrum Willd.
Polygonum hydropiperoides Michx.
Polygonum lapathifolium L.
Polygonum pensylvanicum L.
Polygonum persicaria L. (Bryson 5096 & Newton, SWSL)
Polygonum punctatum Elliott (Clarke s.n., SWSL)
Polygonum scandens L. var. *cristatum* (Engelm. & A. Gray) Gleason
Polygonum setaceum Kunth
Polygonum virginianum L.
Rumex altissimus Alph. Wood
Rumex crispus L.
Rumex obtusifolius L.
Rumex pulcher L.
Rumex verticillatus L. (Bryson 7360, SWSL)

Portulacaceae
Calandrinia ciliata (Ruiz & Pav.) DC. (Bryson 23315, SWSL)
Claytonia virginica L. (Bryson 5190, SWSL)
Portulaca oleracea L.

Primulaceae
Samolus valerandi L. subsp. *parviflorus* (Raf.) Hultén

Ranunculaceae
Clematis crispa L.
Clematis terniflora DC. var. *terniflora*
Clematis x jackmanii T. Moore (Bryson 8122, SWSL)
Myosurus minimus L.
Ranunculus abortivus L.
Ranunculus arvensis L.
Ranunculus bulbosus L.
Ranunculus muricatus L. (Skojac 1223, CBHRL)
Ranunculus parviflorus L. (Bryson 14819, SWSL)
Ranunculus pusillus Poir.
Ranunculus recurvatus Poir.
Ranunculus sardous Crantz
Ranunculus sceleratus L.

Rhamnaceae
Berchemia scandens (Hill) K. Koch

Rosaceae
Crataegus marshallii Eggl. (Carter et al. 1990)
Crataegus viridis L.
Duchesnea indica (Andrews) Focke
Geum canadense Jacq.

Photinia pyrifolia (Lam.) K. R. Robertson & J. B. Phipps (Gunn 10592, SWSL)
Prunus angustifolia Marshall (Bryson 5816 & Morris, SWSL)
Prunus caroliniana Aiton
Prunus mexicana S. Watson (Carter et al. 1990)
Prunus persica (L.) Batsch
Pyracantha coccinea M. Roem.
Pyrus calleryana Decne. (Bryson23770 & Gardiner, SWSL)
Pyrus communis L.
Rosa multiflora Thunb.
Rubus argutus Link
Rubus trivialis Michx.

Rubiaceae
Cephalanthus occidentalis L.
Diodia teres Walter
Diodia virginiana L.
Galium aparine L.
Galium circaezans Michx.
Galium obtusum Bigelow (Bryson 5673 & Morris, SWSL)
Galium tinctorum (L.) Scop. (Skojac 197; 1100, CBHRL)
Galium triflorum Michx.
Houstonia micrantha (Shinners) Terrell (Bryson 5346, SWSL)
Richardia scabra L.
Sherardia arvensis L. (Bryson 14817, SWSL)
Spermacoce glabra Michx.

Rutaceae
Poncirus trifoliata (L.) Raf.
Zanthoxylum clava-herculis L.

Salicaceae
Populus alba L.
Populus deltoides Bartram ex Marsh.
Salix discolor Muhl. (Bryson 4529, SWSL)
Salix fragilis L. (Bryson 4530, SWSL)
Salix interior Rowlee
Salix nigra Marsh.
Salix x *sepulcralis* Simonk. (Bryson 23771 & Gardiner, SWSL)

Sapindaceae
Cardiospermum halicababum L.

Sapotaceae
Sideroxylon lanuginosum Michx. (Bryson 4834, SWSL)
Sideroxylon lycioides L.

Saururaceae
Saururus cernuus L.

Scrophulariaceae
Bacopa rotundifolia Wettst.
Gratiloa neglecta Torr.
Gratiola virginiana L.
Leucospora multifida (Michx.) Nutt.
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperr.
Lindernia dubia (L.) Pennell var. *dubia*
Mazus pumilus (Burman f.) Stennis
Mimulus alatus Aiton
Nuttallanthus canadensis (L.) D. A . Sutton
Paulownia tomentosa (Thunb.) Siebold & Zacc. ex Steud. (Skojac 1139, CBHRL)
Penstemon laevigatus Aiton
Penstemon tenuis Small (Bryson 5649, SWSL)
Scrophularia marilandica L.
Verbascum thapsus L.
Veronica hederaefolia L. (Bryson 5211, SWSL)
Veronica perigrina L.
Veronica persica Poir. (Bryson 13439, SWSL)

Simaroubaceae
Ailanthus altissima (Mill.) Swingle (Bryson 8185, SWSL)

Solanaceae
Capsicum annuum L. (Bryson 15652, SWSL)
Datura strumonium L. var. *tatula* (L.) Torr.
Physalis angulata L.
Physalis heterophylla Nees
Physalis philadelphica Lam. (Bryson 17285, SWSL)
Physalis pubescens L.
Physalis longifolia Nutt. var. *subglabrata* (Mack. & Bush) Cronquist
Solanum americanum Mill.
Solanum carolinense L.
Solanum dimidiatum Raf. (Bryson 15820, SWSL)
Solanum elaegnifolium Cav.
Solanum ptycanthum Dunal
Solanum rostratum Dunal
Solanum sisymbriifolium Lam. (Bryson 15457, SWSL)

Sphenocleaceae
Sphenoclea zeylandica Gaertn.

Sterculiaceae
Firmiana platanifolia (L.) W. Wight (Bryson 8350, SWSL)

Styracaceae
Styrax americana Lam.

Tiliaceae
Tilia americana L. var. *heterophylla* (Vent.) Louden

Ulmaceae
Celtis laevigata Willd.
Planera aquatica J. F. Gmel.
Ulmus alata Michx.
Ulmus americana L.
Ulmus crassifolia Nutt.

Urticaceae
Boehmeria cylindrica (L.) Sw.
Laportea canadensis (L.) Wedd. (Saucier 14, SWSL)
Parietaria pensylvanica Willd. (Skojac 1106, SWSL)
Pilea pumila (L.) A. Gray (Skojac 1106, SWSL)
Urtica chamaerdryoides Pursh
Urtica dioica L. subsp. *gracilis* (Aiton) Steud.

Valerianaceae
Valerianella radiata (L.) Dufr.

Verbenaceae
Callicarpa americana L. (Carter et al. 1990)
Phyla lanceolata (Michx.) Greene
Phyla nudaflora (L.) Greene (Morris 2906 &Bryson, SWSL)
Verbena bonariensis L. (Bryson 23776, SWSL)
Verbena bracteata Cav. ex Lag. & Rodr.
Verbena brasiliensis Vell.
Verbena urticifolia L.
Verbena xutha Lehm.
Vitex agnus-castus L. (Libous-Bailey s.n., SWSL)

Violaceae
Viola arvensis Murray (Bryson 8120, SWSL)
Viola bicolor Pursh (Bryson 5132, SWSL)
Viola missouriensis Greene
Viloa soria Willd.

Vitaceae
Ampelopsis arborea (L.) Koehne
Ampelopsis cordata Michx.
Parthenocissus quinquefolia (L.) Planch.
Vitis aestivalis Michx.

Vitis cinerea (Engelm.) Engelm. ex Mill. (Bryson 4830, SWSL)
Vitis palmata Vahl
Vitis rotundifolia Michx.

Zygophyllaceae
Tribulus terrestris L.

TABLE 2. Species cited in Gunn et al. (1980) from adjacent or Delta Region counties have not been detected within Washington County, Mississippi.

PTERIDOFITAS

Ophioglossaceae
Botrychium dissectum Spreng.

LILIOPSIDA

Commelinaceae
Commelina erecta L.

Cyperaceae
Cyperus echinatus (L.) Wood

Juncaceae
Juncus dichotomus Elliott
Juncus nodatus Coville

Lemnaceae
Lemna perpusilla Torr.
Wolffiella gladiata (Hegelm.) Hegelm.

Orchidaceae
Listera australis Lindl.
Tipularia discolor (Pursh) Nutt.

Poaceae
Agrostis gigantea Roth
Coelarachis cylindrica (Michx.) Nees
Eragrostis capillaris (L.) Nees
Eriochloa contracta Hitchc.
Saccharum baldwinii Spreng.
Saccharum giganteum (Walter) P. Beauv.
Steinchisma hians (Elliott) Nash

MAGNOLIOPSIDA

Apiaceae
Cicuta maculata L.
Cryptotaenia canadensis (L.) DC.
Eryngium prostratum DC.

Asteraceae
Ageratina altissima (L.) King & H. Rob. var. *altissima*
Carduus nutans L.
Crepis pulchra L
Erigeron tenuis Torr. & A. Gray
Pseudognaphalium obtusifolium (L.) Hilliard & B. L. Burtt

Brassicaceae
Cardamine parviflora L. subsp. *arenicola* (Britton) Schulz
Erysimum repandum L.
Nasturtium officinale W. T. Aiton
Rorippa sylvestris (L.) Besser

Caryophyllaceae
Cerastium viscosum L.

Clusiaceae
Hypericum walteri (J. G. Gmel.) Gleason

Ericaceae
Monotropa uniflora L.

Euphorbiaceae
Acalypha gracilens A. Gray
Euphorbia marginata Pursh
Phyllanthus carolinensis Walter

Fabaceae
Apios americana Medik.
Centrosema virginianum (L.) Benth.
Desmodium perplexum G. B. Schub.
Galactia volubilis (L.) Britton
Vicia grandiflora Scop.
Vicia ludoviciana Nutt.

Hydrophyllaceae
Nemophila aphylla (L.) Brummitt

Lamiaceae
Monarda citriodora Cav. ex Lag.
Scutellaria lateriflora L.

Lauraceae
Lindera melissifolia (Walter) Blume

Lythraceae
Ammannia auriculata Willd.
Rotala ramosior (L.) Koehne

Malvaceae
Sida elliottii Torr. & A. Gray

Melostomataceae
Rhexia mariana L.

Ongraceae
Gaura longiflora Spach

Polygonaceae
Polygonum hydropiper L.
Rumex conglomeratus Murray

Primulaceae
Lysimachia radicans Hook.

Ranunculaceae
Ranunculus flabellaris Raf.

Scrophulariaceae
Agalinis tenuifolia (Vahl) Raf.
Nuttallanthus texanus (Scheele) D. A. Sutton
Scrophularia marilandica L.

Verbenaceae
Verbena halei Small

Violaceae
Viola affinis Leconte
Viola cucullata Aiton

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PISTACIA CHINENSIS (ANACARDIACEAE) NATURALIZED IN NORTH CAROLINA, U.S.A.

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ABSTRACT

Pistacia chinensis is reported as naturalized in North Carolina. Diagnostic characters are discussed and the species is distinguished from *Rhus copallinum* which exhibits similar seedlings.

RESUMEN

Se reporta *Pistacia chinensis* naturalizada en Carolina del Norte. Se discuten los caracteres diagnósticos y se distingue de la especie *Rhus copallinum*, la cual exhibe plantas juveniles similares.

Pistacia chinensis Bunge (Anacardiaceae) is a deciduous, dioecious tree species native to Asia (China, Philippines, Taiwan; Min & Barfod 2008). The species has been reported to be spreading from cultivation and slowly naturalizing in a number of states including Alabama, California, Georgia, and Texas (McWilliams 1991; Texas Non-Native Plants Group 2010; USDA 2011), and now North Carolina. Individuals of the species have been variously planted in city parks and private yards in Raleigh, North Carolina, since at least 1947 (*Fox s.n.*, NCSC). Mature females usually produce copious fruit crops which are dispersed by birds (McWilliams & Arnold 1998; Smith et al. 2008; Krings, pers. obs. [Cedar Waxwings]). In the cities of Raleigh and Cary, seedlings and young trees now appear sporadically in waste places, disturbed margins, and untended beds—similar habitats to those invaded by *Ailanthus altissima* (Mill.) Swingle (Simaroubaceae). Continued promotion as an urban tree through such programs as the City of Raleigh's NeighborWoods, will likely accelerate the spread of *P. chinensis*, much as increased availability has in Texas and Australia (McWilliams 1991; Smith et al. 2008).

In the Carolinas, *Pistacia chinensis* is likely to be most confused at a glance with *Rhus copallinum* L. (Anacardiaceae). When mature, the two can be distinguished vegetatively by (1) the rachis (winged only between the distal 1–2 pairs of leaflets, if at all, in *P. chinensis* vs. distinctly winged between all pairs of leaflets in *R. copallinum*) and (2) the number of leaflets (frequently both imparipinnate and paripinnate leaves present on same individual in *P. chinensis* vs. essentially invariably imparipinnate in *R. copallinum*; Fig. 1a, b, c, i). In addition, the rachis pubescence in *P. chinensis* tends to be limited to the adaxial ridge or at least be more pronounced adaxially, whereas in *R. copallinum* it is ubiquitous.

As young seedlings, *P. chinensis* and *R. copallinum* are exceedingly similar and easy to confuse. Both species exhibit a typical anacardiaceous odor and seedlings of both tend to exhibit imparipinnate leaves that are unwinged or only slightly winged (Fig. 1c, i). Paripinnate leaves are apparently rare in young seedlings of *P. chinensis*. The two species may be distinguished at the seedling stage (as well as later in maturity) by the buds. The terminal buds are well-developed in *P. chinensis*, but absent in *R. copallinum* (Fig. 1d, g). In *P. chinensis*, the axillary buds exhibit outer scales that are obtuse and glabrous or pubescent in lines, and inner scales that are aristate or acute and usually glabrous (Fig. 1e). Scale margins, particularly in mature individuals may be densely short-ciliate. Axillary buds in *R. copallinum*, in contrast, are naked, rounded, and densely pubescent throughout (Fig. 1h). As they mature, individuals of *R. copallinum* will develop more and more pronounced rachis wings, although the leaves will remain decidedly imparipinnate. *Pistacia chinensis* individuals, in contrast, will not develop conspicuous rachis wings between each pair of leaflets, but will bear numerous paripinnate leaves to the point that paripinnate leaves may dominate on any one individual when mature.

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Fig. 1. Morphology of *Pistacia chinensis* (a–f) and *Rhus copallinum* (g–i): **a**, paripinnate leaf of mature tree; **b**, imparipinnate leaf of mature tree; **c**, imparipinnate leaf of seedling; **d**, terminal bud, note aristate tips of inner scales; **e**, axillary bud, note acuminate tips; **f**, drupe; **g**, twig terminus, note absence of terminal bud; **h**, axillary bud (naked and pubescent); **i**, leaf of seedling, note rachis wing developed only between terminal two leaflet pairs. (Photos: A. Krings; a, b, d, e: Green Park and vicinity, Raleigh; c, f: North Cary Park, Cary; g–i: Edge of *Pinus taeda* stand, Schenck Forest, Raleigh)

Pistacia chinensis Bunge, Enum. Pl. China Bor. 15. 1833.

Voucher specimens: **NORTH CAROLINA. Wake Co.:** Raleigh, Johnson St., spontaneous in weedy bed, 35°47.277'N, 78°39.173'W, 29 Aug 2011, *Krings 2459* (NCSC); Raleigh, spontaneous in disturbed edge flanked by two urban parking lots, with *Ailanthus altissima*, *Broussonetia papyrifera*, *Carya illinoensis*, *Hedera helix*, and *Lonicera japonica*, 35°47.284'N, 78°38.396'W, 29 Aug 2011, *Krings 2463* (NCSC).

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BOOK NOTICE

NEAL K. VAN ALFEN, GEORGE BRUENING, AND JAN E. LEACH (EDS). 2011. **Annual Review of Phytopathology, Volume 49.** (ISSN 0066-4286; ISBN 978-0-8243-1349-4, hbk.). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 800-523-8635, 650-493-4400). $86.00 indiv., 576 pp., 7⅝" × 9⅜".

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CHECKLIST OF THE VASCULAR PLANTS OF INDIANA COUNTY, PENNSYLVANIA

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ABSTRACT

Indiana County, Pennsylvania has been formally botanized since 1883, but a checklist of the county's vascular flora has not previously been compiled. A search of herbaria augmented by targeted fieldwork has resulted in a list of 1004 taxa of native and naturalized plants comprising 463 genera and 125 families. The five families with the largest number of taxa are Asteraceae, Poaceae, Cyperaceae, Rosaceae, and Lamiaceae. *Carex*, *Viola*, *Solidago*, *Symphyotrichum*, and *Persicaria* are the five largest genera. There are approximately 193 non-native species that have been introduced mainly from Europe and Asia. This checklist recognizes 51 species of Pteridophytes, 8 species of Gymnosperms and 929 species of Angiosperms. Fifteen species have global or state ranking.

RESUMEN

Indiana County, Pennsylvania ha sido formalmente muestreada botánicamente desde 1883, pero no se había compilado previamente un catálogo de la flora vascular del condado. Una búsqueda en herbarios incrementada por trabajos de campo ha dado como resultado una lista de 1004 taxa de plantas nativas y naturalizadas de 463 géneros y 125 familias. Las cinco familias con mayor número de taxa son Asteraceae, Poaceae, Cyperaceae, Rosaceae, y Lamiaceae. *Carex*, *Viola*, *Solidago*, *Symphyotrichum*, y *Persicaria* son los cinco géneros más grandes. Hay aproximadamente 193 especies exóticas que se han introducido de Europa y Asia. En este catálogo se reconocen 51 especies de Pteridófitos, 8 especies de Gimnospermas y 929 especies de Angiospermas. Quince especies están amenazadas a nivel global o de estado.

INTRODUCTION

Even though Pennsylvania lacks checklists for most of its counties, the vascular flora known thus far is quite diverse. Rhoads and Klein (1993) reported 3318 taxa of vascular plants for the state, including 2076 native and 1242 introduced. Approximately 26 of Pennsylvania's 67 counties have floras completed, but some are unpublished theses and surveys and therefore unavailable to the public. The exact number of genera and species in the flora of Indiana County was not previously known because a checklist had never been compiled. Such checklists provide baseline information that can be used to monitor environmental changes and guide conservation decisions.

Site Description

Indiana County, Pennsylvania, is located in the western-central part of the state (Fig. 1). It is bordered by Jefferson County to the north, Clearfield County to the northeast, Cambria County to the southeast, Westmoreland County to the south, and Armstrong County to the west. The county contains approximately 321 sq. mi.

Indiana County receives a total annual precipitation of approximately 46 inches. Average seasonal snowfall is 57 inches annually.

The average date of the last frost in the spring is usually around May 15th and the first frost of the season is approximately October 5th. The length of the growing season, from the last killing frost in spring to the first killing frost in autumn, is between 121–180 days.

The soils of the county consist of eight main series: Gilpin-Weikert-Ernest association, Gilpin-Wharton-Cavode association, Gilpin-Clymer-Wharton association, Gilpin-Wharton-Upshur association, Gilpin-Westmoreland-Guernsey association, Dekalb-Clymer-Cookport association, Dekalb-Clymer-Ernest association, and Monongahela-Allegheny-Pope-Philo association.

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Fig. 1. Small map contains Counties in Pennsylvania. Larger map consists of a major river, streams and municipalities in Indiana County.

Rolling hills with narrow to broad, rolling ridgetops characterize the Gilpin-Weikert-Ernest association. Sandstone-capped ridgetops, remnants of an old plateau, are in the north-central part. The narrow stream-cut valleys contain numerous small streams. This association occurs mainly in the western part of the county but extends to the central and north-central parts and makes up about 32 percent of the county. These soils range from shallow to moderately deep to deep and are somewhat poorly drained to moderately well-drained. Much of the association is idle and has been taken over by brush and weeds. Farmsteads, residential housing and highways are on the gently sloping hills.

Gilpin-Wharton-Cavode association is characterized by broad, sloping hilltops and narrow valleys carved out by streams that form a branching pattern. This area is mainly in the northern and central parts of the county and covers about 19 percent of the county. The soil ranges from shallow to moderately deep and is poorly to well-drained. The gentle and moderate slopes of this association were used for agriculture. Strip mining is common in this association.

Rolling hills with gently sloping, plateau-like hilltops characterize the Gilpin-Clymer-Wharton associa-

tion. Streams with narrow floodplains form a branching pattern flowing into the Conemaugh River. This association covers about 10 percent of the county and is confined to the southeastern part. The soils range from shallow to moderately deep and are poorly drained to well-drained. The association is suitable for agriculture.

Gilpin-Wharton-Upshur association has broad and gentle uplands, sloping banks, and steep hills. Slopes range from gentle near stream headwaters to strong downstream. The soils are moderately deep to deep and moderately to well-drained. This soil association occurs mainly in the southwestern and central parts of the county and makes up about 6 percent of the county. Much of this area has been cleared. Some of the cleared areas are under continued suburban development while others are used for recreation, are farmed or remain idle. Artificial drainage is needed in many areas while other areas are susceptible to landslides.

Gilpin-Westmoreland-Guernsey association is dissected by many small streams. The topography is rolling and hilly and includes some gently sloping benches, saddles, and hilltops. This association is at the southwestern edge of the county and occupies about 1 percent of the county. The soils are moderately deep and well-drained or somewhat poorly drained. Much of the area is taken up by dairy farms.

Dekalb-Clymer-Cookport association is comprised of broad, gently rolling ridgetops and narrow stream-cut valleys with steep sides. The lower part of the valley slopes, along the floodplains, contain many large boulders from the sandstone uplands. This association occurs in the eastern and northern part of the country and makes up about 14 percent of the county. The soils are shallow to moderately deep and poorly drained to well-drained. Woods, woodland pasture and converting farmland covers most of this association. Residential development is mostly along improved highways.

Dekalb-Clymer-Ernest association contains narrow to broad floodplains along small streams and the Conemaugh River, and includes the steep slopes that rise from the floodplains. Large fragments of sandstone have washed down to the lower part of the valley and floodplains. This association is in the southeastern part of the county and covers about 11 percent of the county. The soils are shallow to deep, very stony, and somewhat poorly drained to well-drained. This association is mostly woodland.

Monongahela-Allegheny-Pope-Philo association consists of the first and second bottoms of the larger streams, and includes meandering streams, smooth floodplains, and dissected terraces. The association is in the southeastern part of the county and covers about 7 percent of the county. The soils are deep and moderately well-drained to somewhat poorly drained. Intense farming has occurred on the well-drained floodplains, while some areas have recently been developed for industrial and residential use. (USDA 1968).

Indiana County consists of a hilly region on the Allegheny Plateau that rises to the Allegheny Mountains and is drained by the Crooked, Yellow, Two Lick, Blacklick, and Little Mahoning creeks. Other bodies of water include the Conemaugh River, which bounds Indiana County to the south, and Yellow Creek Lake, which is surrounded by Yellow Creek State Park.

Indiana County contains six major watersheds. These major watersheds are grouped into three subbasin categories: the Central Allegheny Subbasin, the Lower Allegheny Subbasin, and the Upper West Branch Susquehanna Subbasin.

The Central Allegheny Subbasin has a total drainage area of 2930 square miles. This subbasin includes the portion of the Allegheny River between Emlenton and Clinton. This subbasin encompasses almost all of Jefferson County, much of Clarion, Armstrong, Elk, Indiana and portions of Butler, Forest, McKean, and Clearfield counties.

The Central Allegheny Subbasin contains the Cowanshonnock-Crooked Creeks Watershed, the Lower Clarion River Watershed, the Mahoning Creek Watershed, the Redbank Creek Watershed and the Upper Clarion River Watershed. The Cowanshonnock-Crooked Creeks and Mahoning Creek Watersheds drain northern Indiana County.

The Cowanshonnock-Crooked Creeks Watershed has a total drainage area of 502 square miles and its major streams include Cowanshonnock Creek and Crooked Creek. Crooked Creek flows west to east through the east central portion of Indiana County.

The Mahoning Creek Watershed has a total drainage area of 444 square miles and its major waterways

include Mahoning Creek and Little Mahoning Creek. Mahoning Creek lies in the extreme northern portion of the county, and the Little Mahoning Creek flows through the northern portion of Indiana County.

The Lower Allegheny Subbasin has a total drainage area of 2394 square miles. It includes the lowermost portion of the Allegheny River from Clinton to Pittsburgh, including the entire Kiskiminetas-Conemaugh River system. The subbasin encompasses much of Allegheny, Indiana, Cambria, Somerset and Westmoreland Counties with portions of Butler and Armstrong Counties. Watersheds of the Lower Allegheny Subbasin that drain Indiana County include the Conemaugh River-Blacklick Creek Watershed, the Kiskiminetas River Watershed, and the Loyalhanna Creek Watershed.

The Conemaugh River-Blacklick Creek Watershed has a total drainage area of 700 square miles and its major waterways include Blacklick Creek, Two Lick Creek and the middle portion of the Conemaugh River. These waterways drain the southern portion of Indiana County.

The Kiskiminetas River Watershed has a total drainage area of 164 square miles and its major waterways include Kiskiminetas River, which drains a small portion of southwestern Indiana County, and Beaver Run.

Loyalhanna Creek Watershed consists of 370 square miles of total drainage area and includes Blacklegs Creek and the lower portion of the Conemaugh River. These waterways also drain the southwestern portion of Indiana County.

The Upper West Branch Susquehanna Subbasin has a total drainage area of 2631 square miles. It includes the West Branch Susquehanna River from its origins to just downstream of Sinnemahoning Creek. This subbasin encompasses almost all of Cameron County, much of Clearfield, Cambria, Centre, Elk and Potter Counties and portions of Indiana, Clinton, Blair, McKean, and Jefferson Counties. The Upper West Branch Susquehanna Subbasin contains the Chest-Anderson Creeks Watershed. Tributaries in the northeastern edge of the county flow into the West Branch Susquehanna River (Pennsylvnia DEP Watershed Notebook 2006).

History

Archaeological remains indicate the presence of Native American in Indiana County as early as 14,225 B.C. Records indicate that the Delaware Indians were here during the 1720s and the Shawnee Indains came shortly after. The first documented European to arrive was a trader named James Letort in approximately 1727. In 1768 the Treaty of Fort Stanwix made settlement legal. The first towns were Newport in 1790 and Armagh in 1792. Two parts of Indiana County, north and south of the Purchase Line, were joined when the county was created by the Pennsylvania Legislature in 1803.

Beginning in 1813, except for agriculture, the manufacture of salt was the first major industry in the area. The salt boom in the southwestern part of the county accounted for the name of the town of Saltsburg. The town of Saltsburg was founded in 1816 and in 1828 the first steam engines were put into use at the saltworks. The use of coal increased until 1838 and then declined slowly as the salt production diminished. The first iron foundry was in Blairsville in 1830, and the first iron furnace began working in East Wheatfield in 1840. Timber production began in 1827.

According to the census of 1810, the new county had a population of 1214. The town of Indiana became a borough in 1816, the same year Pittsburgh was incorporated as a city. The Pennsylvania Canal, opened for vessel traffic from Saltsburg to Blairsville in 1829, and was one of the most important transportation improvements at that time. The Huntingdon, Cambria and Indiana Turnpike was completed by 1821, and another turnpike from Ebensburg to Kittanning via Indiana opened in 1823.

During the 1850's the local economy slowed down in response to the decline of the coal-mining and salt industries. The Indiana County Agricultural Society was formed and held its first county fair in 1855. In 1851 the railroad extended into Indiana County as far as Blairsville and reached into Indiana by 1856 and Saltsburg by 1865.

Agriculture and timber harvesting were the chief economic activities during the 1880's. New mines sprang up in Glen Campbell between 1889 and 1890. Other industries produced glass, bricks, cigars, wagons, and carriages. By 1883 Sutton Brothers and Bell of Indiana was the largest iron foundry in the area. From 1887

to 1889 new railroads reached into the northeastern sections of the county. Eight bridges spanned the Conemaugh River. Indiana had telegraph service by 1869, and by 1890, 21 towns had telephone service.

By 1915 there were 53 mining companies in operation, with approximately 115 mines. Coal production grew from 1901 to 1910. The coal boom stimulated the growth of other industries and establishment of new companies. Among them were the Indiana Foundry Company in 1899; Clymer Brick and Fire Clay Company in 1907; McCreary Tire and Rubber Company in 1915; and the Indian Brewing Company in 1904, to name just a few. A number of glass companies were established in Blairsville and Indiana, and electricity-generating plants grew up in both towns in 1890 and 1891.

The Buffalo, Rochester and Pittsburgh Railroad began in 1902, and the New York Central from 1903. By 1903, there were only six automobiles registered in the entire county. Construction of a street car system from Indiana to Ernest and Clymer began in 1906 and was completed as far as Blairsville by 1910. Streetcar service ended by 1933 and the Pennsylvania Railroad discontinued passenger service in 1940.

A concrete road was built from Indiana to Homer City in 1921. The first airfield built in the area was in 1918. In 1932, 32 percent of the population was receiving emergency relief. By 1935 the county owned 26 percent of all taxable real estate consisting of 3800 parcels, but by 1937 the local economy was beginning to recover.

World War II was upon the county in 1940. Schools conducted salvage drives and students picked elderberries and milkweed pods to help families. In 1943, the government took over the mines and there were very few local war industries. Below lists some of the technological and cultural advances that the county experienced during the 1940's and 50's. WDAD, the first radio station, went on the air in 1945. An Associated Press dispatch in 1950s announced Indiana County as "the Christmas Tree Capital of the World." The first of three giant electric plants were completed in 1967. The Hamilton Airfield closed in 1950 but was replaced by the Jimmy Stewart Airport in honor of the actor who grew up in Indiana County. Among the problems was an economic decline that had begun immediately after the war ended, resulting in a loss of population. By 1970 the population had recovered to the 1940 level. Today, Indiana University of Pennsylvania is the largest employer in the county. Farming is again the number one industry, with tourism coming in second (Busovicki 2003).

Major Collectors

Collecting in Indiana County for the Carnegie Museum Herbarium began in 1883, and has continued to the present. Most of the collectors have been members of the Botanical Society of Western Pennsylvania and the staff of the Section of Botany at Carnegie Museum.

Botanists who have made significant contributions to the knowledge of the Indiana County are L. Speedy, L.K. Henry, O.E. Jennings, W.E. Buker, and F.H. Utech.

METHODS

This checklist was compiled by searching the herbaria of the Carnegie Museum of Natural History (CM). Herbarium collection information was obtained from the Morris Arboretum (MOAR) for 24 samples. Other herbaria that were examined for specimens include the Academy of Natural Sciences of Philadelphia (21 samples) and the A.G. Shields herbarium at the Indiana University of Pennsylvania (83 samples). In addition fieldwork was conducted targeting underrepresented areas of the county. Most of the collections were made 2007 through 2009, as well as during the late 1940s and early 1950s but several specimens date back as far as 1895 and 1901. The majority of the specimens are deposited at the Carnegie Museum of Natural History (CM). Rhoads and Block (2000) was the primary source for plant identification. For generic and species names we have generally followed the Synthesis of North American Flora (Kartesz 1999). Authorities are abbreviated for the majority of taxa according to Brummitt and Powell (1992).

RESULTS AND DISCUSSION

This list includes the names of all native and naturalized species known to occur in Indiana County. It includes a total of 125 families, 463 genera, and 988 species. The five families with the largest number of species are

Asteraceae, Poaceae, Cyperaceae, Rosaceae, and Lamiaceae. *Carex*, *Viola*, *Solidago*, *Symphyotrichum*, and *Persicaria* are the largest genera. This checklist recognizes 51 species of pteridophytes, 8 species of gymnosperms and 929 species of angiosperms. There are approximately 193 non-native species that have been introduced mainly from Europe and Eurasia. Fifteen species have global or state ranking.

Species of Conservation Concern

Of the 15 plants that have global or state ranking, none have a global ranking of G2 or imperiled status but are either a G4 or G5 status, indicating an apparently secure or secure condition globally. No taxon listed under the Endangered Species Act was encountered.

Actaea podocarpa G4:S3
Andropogon glomeratus var. **glomeratus**, G5:S3
Filipendula rubra G4G5:S1S2
Helianthus microcephalus G5:S4
Hydrastis canadensis G4:S4
Najas gracillima G5?:S4
Orontium aquaticum G5:S4
Penstemon laevigatus G5:S3
Prenanthes crepidinea G4:S4
Salix petiolaris G5:S4
Stenanthium gramineum G4G5:S1S2
Symphyotrichum praealtum var. **angustior**, G5:S3
Taxus canadensis G5:S3S4
Thalictrum coriaceum G4:S2
Trillium flexipes G5:S2

Invasives

There are 4 taxa in the Indiana County flora that are listed by the Pennsylvania Department of Agriculture (2007) as noxious weeds. It is therefore illegal to propagate, sell or transport the following taxa in the commonwealth: *Cirsium arvense* (Canada thistle), *Cirsium vulgare* (Bull thistle), *Lythrum salicaria* (Purple loosestrife), and *Rosa multiflora* (Multiflora rose). Other species considered serious invasives in Pennsylvania's native ecosystems are: *Acer platanoides* (Norway maple), *Aegopodium podagraria* (goutweed), *Ailanthus altissima* (tree-of-heaven), *Alliaria petiolata* (garlic mustard), *Berberis thunbergii* (Japanese barberry), *Celastrus orbiculatus* (Oriental bittersweet), *Elaeagnus umbellata* (autumn olive), *Hesperis matronalis* (Dame's rocket), *Ligustrum obtusifolium* (border privet), *Lonicera japonica* (Japanese honeysuckle), *Lonicera maackii* (Amur honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Microstegium vimineum* (Japanese stilt grass), *Myriophyllum spicatum* (Eurasian water-milfoil), *Pastinaca sativa* (wild parsnip), *Phalaris arundinacea* (reed canary grass), and *Spiraea japonica* (Japanese spiraea) (DCNR 2004).

While this checklist is probably not all-inclusive of every species in Indiana County, it is the most comprehensive list presently available.

ANNOTATED CHECKLIST OF THE SPECIES OF INDIANA COUNTY, PENNSYLVANIA

Taxa are listed according to the following format: taxon name, author(s), {(year) collector and number} **global: state ranking,** [Synonyms] and non-native source. We follow the state (S) and global (G) ranking systems developed by The Nature Conservancy (1996 version). The global numbers are designated from 1 (critically imperiled) to 5 (secure). Other notations include SH, which denotes historical occurrence, and SR, which indicates reported without persuasive documentation. Synonyms are included for names not in common usage in the state or regional manuals. In cases where there was more than one specimen present in the collection, recent collections of current collectors for the western Pennsylvania region were cited.

Families, genera, and specific and infraspecific taxa are arranged alphabetically within vascular plant groups Angiosperms, Gymnosperms, and Pteridophytes.

ANGIOSPERMS

Acanthaceae

Justicia americana (L.) Vahl, 1968 A.G. Shields s.n.

Aceraceae

Acer negundo L. var. *negundo*, 2007 L. Speedy LS-07-47
Acer nigrum Michx. f., 2008 L. Speedy 08-991 [*Acer saccharum* Marsh. var. *nigrum* (Michx. f.) Britt.]
Acer pensylvanicum L., 2008 L. Speedy 08-0291
Acer platanoides L., 2008 L. Speedy 08-0048 Europe
Acer rubrum L. var. *rubrum*, 2009 L. Speedy 09-0204-2
Acer rubrum L. var. *trilobum*, 1950 L.K. Henry and F.H. Beer s.n.

Acer saccharinum L., 2008 L. Speedy 08-992
Acer saccharum Marsh. var. *saccharum*, 2008 L. Speedy 08-946
Acer spicatum Lam., 2008 L. Speedy 08-0278

Acoraceae
Acorus calamus L., 1952 L.K. Henry and F.H. Beer s.n. Europe

Alismataceae
Alisma subcordatum Raf., 2009 L. Speedy 09-923 [*Alisma plantago-aquatica* L. var. *parviflorum* (Pursh) Torr.]
Sagittaria latifolia Willd., 2008 L. Speedy 08-1012

Amaranthaceae
Amaranthus hybridus L., 1947 H.A. Wahl 4894 Tropical America
Amaranthus retroflexus L., 1947 H.A. Wahl 4513 Tropical America

Anacardiaceae
Rhus copallinum L., 2007 L. Speedy, C. Tracey and S. Stewart 07-1011
Rhus glabra L., 1945 O.E. Jennings s.n.
Rhus typhina L., 2009 L. Speedy 09-1072
Toxicodendron radicans (L.) Kuntze ssp. *negundo*, 2009 L. Speedy 09-0247

Annonaceae
Asimina triloba (L.) Dunal, 2008 L. Speedy 08-1180

Apiaceae
Aegopodium podagraria L., 2008 L. Speedy 08-629 Eurasia
Angelica venenosa (Greenway) Fern., 1951 W.E. Buker and F.H. Beer s.n.
Anthriscus sylvestris (L.) Hoffman, 2008 L. Speedy 08-376 Europe
Chaerophyllum procumbens (L.) Crantz var. *procumbens*, 2002 B.L. Isaac, J.A. Isaac and H.R. Isaac 14305
Cicuta maculata L. var. *maculata*, 2009 L. Speedy 09-0553
Conium maculatum L., 1982 M. Cipollini s.n. Europe
Cryptotaenia canadensis (L.) DC., 2008 L. Speedy 08-389J
Daucus carota L., 2008 L. Speedy 08-1137 Eurasia
Hydrocotyle americana L., 2008 L. Speedy 08-791
Osmorhiza claytonii (Michx.) C.B. Clarke, 1952 L.K. Henry and F.H. Beer s.n.
Osmorhiza longistylis (Torr.) DC., 2008 L. Speedy 08-388B
Pastinaca sativa L., 2009 L. Speedy 09-0587 Eurasia
Sanicula canadensis L. var. *canadensis*, 2008 L. Speedy 08-447
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, 2009 L. Speedy 09-0444 [*Sanicula gregaria* Bickn.]
Sanicula trifoliata Bickn., 1990 F.H. Utech 90-1274
Sium suave Walt., 1952 L.K. Henry and F.H. Beer s.n.
Taenidia integerrima (L.) Drude, 1952 L.K. Henry and F.H. Beer s.n.
Thaspium barbinode (Michx.) Nutt., 1952 L.K. Henry and F.H. Beer s.n.
Thaspium trifoliatum (L.) A. Gray var. *aureum*, 2009 L. Speedy 09-816 [*Thaspium trifoliatum* var. *flavum* Blake]
Zizia aptera (A. Gray) Fern., 2008 L. Speedy 08-339
Zizia aurea (L.) W.D.J. Koch, 2007 L. Speedy 07-782

Apocynaceae
Apocynum androsaemifolium L., 2008 L. Speedy 08-566
Apocynum cannabinum L., 2008 L. Speedy 08-681
Vinca minor L., 2007 L. Speedy LS-07-50 Europe

Aquifoliaceae
Ilex ambigua (Michx.) Torr., 2008 L. Speedy and D. White 08-1244
Ilex montana Torr. & A. Gray ex A. Gray, 2008 L. Speedy 08-1292
Ilex verticillata (L.) A. Gray, 2007 L. Speedy LS-07-423

Araceae
Arisaema dracontium (L.) Schott, 1946 L.K. Henry s.n.
Arisaema triphyllum (L.) Schott ssp. *triphyllum*, 2009 L. Speedy 09-0147
Orontium aquaticum L., 2008 L. Speedy 08-390 **G5:S4**
Symplocarpus foetidus (L.) Salisb. ex Nutt., 2009 L. Speedy 09-823

Araliaceae
Aralia nudicaulis L., 2008 L. Speedy 08-585
Aralia racemosa L. ssp. *racemosa*, 1954 L.K. Henry and W.E. Buker s.n.
Aralia spinosa L., 2008 L. Speedy 08-1014
Panax quinquefolius L., 2008 L. Speedy 08-948
Panax trifolius L., 2008 L. Speedy 08-360

Aristolochiaceae
Asarum canadense L., 2008 L. Speedy 08-366

Asclepiadaceae
Asclepias exaltata L., 2008 L. Speedy 08-527
Asclepias incarnata L. ssp. *incarnata*, 2008 L. Speedy 08-906
Asclepias quadrifolia Jacq., 2008 L. Speedy 08-448
Asclepias syriaca L., 2008 L. Speedy 08-693
Asclepias tuberosa L. ssp. *tuberosa*, 2009 L. Speedy 09-620

Asteraceae
Achillea millefolium L., 2008 L. Speedy 08-688
Ageratina altissima (L.) King & H.E. Robins. var. *altissima*, 2008 L. Speedy 08-1069 [*Eupatorium rugosum* Houtt.]
Ambrosia artemisiifolia L., 2008 L. Speedy 08-1134
Ambrosia trifida L., 1942 O.E. Jennings s.n.
Anaphalis margaritacea (L.) Benth. & Hook. f., 2009 L. Speedy and C. Rogers 09-1078
Antennaria howellii Greene ssp. *neodioica*, 2008 L. Speedy 08-338 [*Antennaria neodioica* Greene]
Antennaria neglecta Greene, 2007 L. Speedy LS-07-311
Antennaria parlinii Fern. ssp. *parlinii*, 2007 L. Speedy LS-07-63
Antennaria plantaginifolia (L.) Richards., 2009 L. Speedy 09-0220
Anthemis arvensis L., 1950 L.K. Henry and F.H. Beer s.n. Europe
Anthemis cotula L., 1982 M. Cipollini s.n. Europe
Arctium lappa L., 2008 L. Speedy 08-804 Europe
Arctium minus (Hill) Bernh., 1994 W.A. Zanol 3539 Eurasia
Arnoglossum atriplicifolium (L.) H.E. Robins., 2008 L. Speedy 08-1182 [*Cacalia atriplicifolia* L.]
Artemisia vulgaris L., 2008 L. Speedy 08-1200 Eurasia
Bidens cernua L., 1984 M. Polechko s.n.
Bidens frondosa L., 2009 L. Speedy 09-911
Bidens tripartita L., 2009 L. Speedy 09-1013 [*Bidens comosa* (A. Gray) Wieg.]
Bidens vulgata Greene, 1951 E.T. Wherry s.n.
Centaurea stoebe L. ssp. *micranthos*, 2009 L. Speedy and B. Poglein 09-849 Eurasia
Cichorium intybus L., 1944 O.E. Jennings s.n. Europe
Cirsium altissimum (L.) Spreng., 1942 O.E. Jennings s.n.
Cirsium arvense (L.) Scop., 2008 L. Speedy 08-884 Eurasia
Cirsium discolor (Muhl. ex Willd.) Spreng., 2008 L. Speedy 08-1184
Cirsium muticum Michx., 2008 L. Speedy 08-1008
Cirsium pumilum Spreng., 1954 L.K. Henry and W.E. Buker s.n.
Cirsium vulgare (Savi) Ten., 1990 F.H. Utech 90-1227 Eurasia
Conyza canadensis (L.) Cronq., 2009 L. Speedy 09-801
Doellingeria umbellata (P. Mill.) Nees var. *umbellata*, 2009 L. Speedy 09-1015 [*Aster umbellatus* P. Mill.]
Erechtites hieraciifolius (L.) Raf. ex DC. var. *hieraciifolius*, 2009 L. Speedy 09-917
Erigeron annuus (L.) Pers., 2008 L. Speedy 08-388D
Erigeron philadelphicus L. var. *philadelphicus*, 2009 L. Speedy 09-0248
Erigeron pulchellus Michx. var. *pulchellus*, 2008 L. Speedy 08-0185
Erigeron strigosus Muhl. ex Willd. var. *strigosus*, 1994 W.A. Zanol 3514
Eupatorium altissimum L., 2009 L. Speedy 09-806
Eupatorium perfoliatum L., 2008 L. Speedy 08-1256
Eupatorium serotinum Michx., 2008 L. Speedy 08-1295

Eupatorium sessilifolium L., 2008 L. Speedy 08-1041
Eurybia divaricata (L.) Nesom, 2008 L. Speedy 08-1337 [*Aster divaricatus* L.]
Eurybia macrophylla (L.) Cass., 2009 L. Speedy 09-796 [*Aster macrophyllus* L.]
Eurybia schreberi (Nees) Nees, 1952 L.K. Henry and F.H. Beer s.n. [*Aster schreberi* Nees]
Euthamia graminifolia (L.) Nutt., 2008 L. Speedy 08-1282 [*Solidago graminifolia* (L.) Salisb.]
Eutrochium fistulosum (Barratt) E. Lamont, 2008 L. Speedy 08-1112 [*Eupatorium fistulosum* Barratt]
Eutrochium purpureum (L.) E. Lamont var. *purpureum*, 2008 L. Speedy 08-1027 [*Eupatorium purpureum* L.]
Galinsoga parviflora Cav. var. *parviflora*, 2008 L. Speedy 08-1301 Central & South America
Galinsoga quadriradiata Ruiz & Pavon, 2008 L. Speedy 08-798 Central & South America
Gnaphalium uliginosum L., 1952 L.K. Henry and F.H. Beer s.n. Europe
Helenium autumnale L., 2009 L. Speedy 09-935
Helenium flexuosum Raf., 1965 A.G. Shields s.n.
Helianthus ×laetiflorus Pers. (pro sp.), 1962 R.A. Ickes s.n.
Helianthus decapetalus L., 2008 L. Speedy 08-1116
Helianthus divaricatus L., 2008 L. Speedy 08-1042
Helianthus microcephalus Torr. & A. Gray, 1942 O.E. Jennings s.n. **G5:S4**
Helianthus strumosus L., 2009 L. Speedy 09-1020
Helianthus tuberosus L., 1974 M. Neidig s.n.
Heliopsis helianthoides (L.) Sweet, 2009 L. Speedy 09-633-2
Hieracium aurantiacum L., 1994 B.L. Isaac and J.A. Isaac 6878 Europe
Hieracium caespitosum Dumort., 1994 B.L. Isaac and J.A. Isaac 6884 Europe
Hieracium paniculatum L., 2007 L. Speedy 07-1105
Hieracium pilosella L., 1982 M. Cipollini s.n. Europe
Hieracium scabrum Michx., 2008 L. Speedy 08-1197
Hieracium venosum L., 2009 L. Speedy 09-649
Hypochaeris radicata L., 1994 B.L. Isaac and J.A. Isaac 6882 Eurasia
Krigia biflora (Walt.) Blake, 1942 R.W. Pohl 3837
Lactuca biennis (Moench) Fern., 2009 L. Speedy 09-932
Lactuca canadensis L., 1954 L.K. Henry and W.E. Buker s.n.
Lactuca sativa L., 1901 J.A. Shafer s.n. Europe
Lactuca serriola L., 1990 F.H. Utech 90-1246 Europe
Leucanthemum vulgare Lam., 1994 W.A. Zanol 3508 Europe
Oclemena acuminata (Michx.) Greene, 2009 L. Speedy and B. Poglein 09-845 [*Aster acuminatus* Michx.]
Oporinia autumnalis D. Don, 1963 F. Serrotto s.n. Europe
Packera aurea (L.) A. & D. Löve, 2009 L. Speedy 09-0196 [*Senecio aureus* L.]
Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Love, 2009 L. Speedy 09-0221 [*Senecio obovatus* Muhl. ex Willd.]
Prenanthes altissima L., 2009 L. Speedy 09-938
Prenanthes crepidinea Michx., 2002 B.L. Isaac, J.A. Isaac and H.R. Isaac 14306 **G4:S4**
Prenanthes trifoliolata (Cass.) Fern., 1951 W.E. Buker and F.H. Beer s.n.
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt ssp. *obtusifolium*, 1995 F.H. Utech 95-899 [*Gnaphalium obtusifolium* L.]
Rudbeckia hirta L. var. *hirta*, 2009 L. Speedy 09-937 [*Rudbeckia hirta* var. *pulcherrima* Farw.]
Rudbeckia laciniata L. var. *laciniata*, 2008 L. Speedy 08-1140
Rudbeckia triloba L. var. *triloba*, 1995 F.H. Utech 95-888
Senecio vulgaris L., 1967 J. Rummel s.n. Eurasia
Sericocarpus asteroides (L.) B.S.P., 1953 L.K. Henry and F.H. Beer s.n. [*Aster paternus* Cronq.]
Silphium asteriscus L. var. *trifoliatum*, 2007 L. Speedy, C. Tracey and S. Stewart 07-1018 [*Silphium trifoliatum* L.]
Solidago altissima L. ssp. *altissima*, 1952 L.K. Henry and F.H. Beer s.n. [*Solidago canadensis* L. var. *scabra* Torr. & A. Gray]
Solidago bicolor L., 2008 L. Speedy 08-1107
Solidago caesia L. var. *caesia*, 2008 L. Speedy 08-1323
Solidago canadensis L. var. *canadensis*, 2008 L. Speedy 08-1120
Solidago canadensis L. var. *hargeri*, 2008 L. Speedy 08-1320
Solidago flexicaulis L., 2008 L. Speedy 08-1265
Solidago gigantea Ait., 2009 L. Speedy 09-819
Solidago juncea Ait., 2008 L. Speedy 08-1122
Solidago nemoralis Ait. var. *nemoralis*, 2009 L. Speedy 09-936
Solidago patula Muhl. ex Willd. var. *patula*, 2009 L. Speedy 09-1012
Solidago rugosa P. Mill. ssp. *aspera* var. *aspera*, 2008 L. Speedy 08-1130
Solidago rugosa P. Mill. ssp. *rugosa* var. *rugosa*, 2008 L. Speedy 08-1189
Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia*, 1952 L.K. Henry and F.H. Beer s.n.
Symphyotrichum cordifolium (L.) Nesom, 2008 L. Speedy 08-1327 [*Aster cordifolius* L.]
Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum* var. *lanceolatum*, 2008 L. Speedy 08-1254 [*Aster simplex* Willd.]
Symphyotrichum lateriflorum (L.) A. & D. Löve var. *lateriflorum*, 2008 L. Speedy 08-1328 [*Aster lateriflorus* (L.) Britt.]
Symphyotrichum novae-angliae (L.) Nesom, 2008 L. Speedy 08-1296 [*Aster novae-angliae* L.]
Symphyotrichum oblongifolium (Nutt.) Nesom, 1966 J. Byers s.n.
Symphyotrichum pilosum (Willd.) Nesom var. *pilosum*, 2008 L. Speedy 08-1129 [*Aster pilosus* Willd.]
Symphyotrichum pilosum (Willd.) Nesom var. *pringlei*, 2009 L. Speedy 09-1016 [*Aster pilosus* Willd. var. *demotus* Blake]
Symphyotrichum praealtum (Poir.) Nesom var. *angustior*, 2009 L. Speedy 09-1017 **G5:S3** [*Aster praealtus* var. *angustior* Wieg.]
Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom, 2008 L. Speedy 08-1347 [*Aster prenanthoides* Muhl. ex Willd.]
Symphyotrichum puniceum (L.) A. & D. Löve var. *puniceum*, 2008 L. Speedy 08-1319 [*Aster puniceus* L.]
Symphyotrichum shortii (Lindl.) Nesom, 2007 L. Speedy 07-1796 [*Aster shortii* Lindl.]
Symphyotrichum undulatum (L.) Nesom, 1948 E. Mason s.n. [*Aster undulatus* L.]
Symphyotrichum urophyllum (Lindl.) Nesom, 2009 L. Speedy 09-1089 [*Aster urophyllus* Lindl.]
Tanacetum parthenium (L.) Schultz-Bip., 1978 M. Tucker s.n. Europe
Taraxacum officinale G.H. Weber ex Wiggers, 2007 L. Speedy LS-07-73 Eurasia
Tussilago farfara L., 2008 L. Speedy 08-0268 Eurasia
Verbesina alternifolia (L.) Britt. ex Kearney, 2008 L. Speedy 08-1070
Vernonia gigantea (Walt.) Trel. ex Branner & Coville, 2009 L. Speedy 09-820
Vernonia noveboracensis (L.) Michx., 2008 L. Speedy 08-1132
Xanthium strumarium L., 1957 L.K. Henry s.n.

Balsaminaceae
Impatiens capensis Meerb., 2007 L. Speedy 07-1094
Impatiens pallida Nutt., 2008 L. Speedy 08-1191

Berberidaceae
Berberis thunbergii DC., 2008 L. Speedy 08-0104 Japan
Caulophyllum thalictroides (L.) Michx., 2009 L. Speedy 09-0101
Podophyllum peltatum L., 2008 L. Speedy 08-397

Betulaceae
Alnus incana (L.) Moench ssp. *rugosa*, 2009 L. Speedy 09-1009
Alnus serrulata (Ait.) Willd., 2009 L. Speedy 09-0284
Betula alleghaniensis Britt., 2008 L. Speedy 08-0086
Betula lenta L., 2009 L. Speedy 09-0142

Betula pendula Roth, 1995 F.H. Utech 95-872 Eurasia
Betula populifolia Marsh., 1977 A. Sibo s.n.
Carpinus caroliniana Walt. ssp. *virginiana*, 2009 L. Speedy 09-675
Corylus americana Marsh., 2008 L. Speedy 08-809-1
Ostrya virginiana (P. Mill.) K. Koch, 2009 L. Speedy 09-1086

Bignoniaceae
Campsis radicans (L.) Seem. ex Bureau, 1967 J. Gelsdorf s.n.
Catalpa bignonioides Walt., 1983 T. Gallagher s.n.
Catalpa speciosa Warder ex Engelm., 2009 L. Speedy 09-678

Boraginaceae
Cynoglossum officinale L., 1954 F. Streams s.n. Eurasia
Cynoglossum virginianum L. var. *virginianum*, 1946 L.K. Henry s.n.
Echium vulgare L., 1994 W.A. Zanol 3549 Europe
Hackelia virginiana (L.) I.M. Johnston, 2008 L. Speedy 08-1071
Mertensia virginica (L.) Pers. ex Link, 2008 L. Speedy 08-0107
Myosotis laxa Lehm., 2007 L. Speedy and C. Tracey 07-972
Myosotis scorpioides L., 2000 H. Travis s.n. Europe

Brassicaceae
Alliaria petiolata (Bieb.) Cavara & Grande, 2008 L. Speedy 08-0276 Europe
Arabidopsis lyrata (L.) O'Kane & Al-Shehbaz ssp. *lyrata*, 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-812
Barbarea vulgaris Ait. f., 2008 L. Speedy 08-0223 Eurasia
Boechera canadensis Al-Shehbaz, 1954 L.K. Henry and W.E. Buker s.n. [*Arabis canadensis* L.]
Boechera laevigata (Muhl. ex Willd.) Al-Shehbaz, 2009 L. Speedy 09-640 [*Arabis laevigata* (Muhl. ex Willd.) Poir.]
Brassica juncea (L.) Czern., 1901 J.A. Shafer s.n. Eurasia
Brassica rapa L., 1958 F. Feduska s.n. Europe
Bunias orientalis L., 1946 H.A. Wahl 1910 Europe
Capsella bursa-pastoris (L.) Medik., 1972 L.K. Henry and W.E. Buker s.n. Eurasia
Cardamine angustata O.E. Schulz, 2007 L. Speedy and C. Tracey LS-07-158
Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., 2009 L. Speedy 09-0215
Cardamine concatenata (Michx.) Sw., 2008 L. Speedy 08-0167
Cardamine diphylla (Michx.) Wood, 2008 L. Speedy 08-0289
Cardamine douglassii Britt., 2008 L. Speedy 08-0055
Cardamine hirsuta L., 2007 L. Speedy LS-07-42 Europe
Cardamine impatiens L., 2008 L. Speedy 08-503 Europe
Cardamine parviflora L. var. *arenicola*, 1946 L.K. Henry s.n.
Cardamine pensylvanica Muhl. ex Willd., 2008 L. Speedy 08-0128
Cardamine rotundifolia Michx., 2007 L. Speedy LS-07-291
Draba verna L., 1915 J. Bright s.n. Europe
Hesperis matronalis L., 2008 L. Speedy 08-388A Europe
Lepidium campestre (L.) Ait. f., 2008 L. Speedy 08-965 Eurasia
Lepidium virginicum L., 2005 J. Kupchella 6
Nasturtium officinale Ait. f., 1968 J. Rummel s.n. Europe
Rorippa palustris (L.) Bess. ssp. *fernaldiana*, 2009 L. Speedy 09-0583
Sinapis arvensis L., 1966 M.R. Charnego s.n. Mediterranean region
Sisymbrium officinale (L.) Scop., 1901 J.A. Shafer s.n. Europe

Buxaceae
Pachysandra terminalis Sieb. & Zucc., 2008 L. Speedy 08-891 Japan

Cabombaceae
Brasenia schreberi J.F. Gmel., 2007 L. Speedy, C. Tracey and S. Stewart 07-986

Callitrichaceae
Callitriche heterophylla Pursh ssp. *heterophylla*, 1953 L.K. Henry and F.H. Beer s.n.

Campanulaceae
Campanulastrum americanum (L.) Small, 2009 L. Speedy 09-792 [*Campanula americana* L.]
Lobelia cardinalis L., 2009 L. Speedy 09-818
Lobelia inflata L., 2009 L. Speedy 09-783
Lobelia siphilitica L., 2008 L. Speedy 08-1348
Lobelia spicata Lam. var. *spicata*, 1953 L.K. Henry and F.H. Beer s.n.
Triodanis perfoliata (L.) Nieuwl., 2008 L. Speedy 08-509

Cannabaceae
Humulus lupulus L., 1969 D. Pifer s.n. Europe

Caprifoliaceae
Diervilla lonicera P. Mill., 1959 W.E. Buker s.n.
Lonicera canadensis Bartr. ex Marsh., 2007 L. Speedy and C. Tracey LS-07-156
Lonicera dioica L., 1963 J. Hamilton s.n.
Lonicera japonica Thunb., 1995 F.H. Utech 95-877 Asia
Lonicera maackii (Rupr.) Herder, 2007 L. Speedy LS-07-221 Asia
Lonicera morrowii A. Gray, 2009 L. Speedy and B. Poglein 09-846 Japan
Lonicera xylosteum L., 2008 L. Speedy 08-440 Eurasia
Sambucus nigra L. ssp. *canadensis*, 2009 L. Speedy and C. Rogers 09-1079 [*Sambucus canadensis* L.]
Sambucus nigra L. ssp. *nigra*, 2007 L. Speedy and C. Tracey LS-07-150 Europe
Sambucus racemosa L. var. *racemosa*, 2008 L. Speedy 08-525 [*Sambucus racemosa* var. *pubens*]
Symphoricarpos orbiculatus Moench, 1966 K. Smay s.n.
Viburnum acerifolium L., 2009 L. Speedy 09-1092
Viburnum dentatum L. var. *lucidum*, 2007 L. Speedy and C. Tracey 07-970 [*Viburnum recognitum* Fern.]
Viburnum lantanoides Michx., 2009 L. Speedy and C. Rogers 09-1082 [*Viburnum alnifolium* Marsh.]
Viburnum lentago L., 2007 L. Speedy and M. Bowers 07-876
Viburnum nudum L. var. *cassinoides*, 2007 L. Speedy and M. Bowers 07-872 [*Viburnum* cassinoides L.]
Viburnum opulus L. var. *opulus*, 1966 J. Peterson s.n. Eurasia
Viburnum prunifolium L., 2007 L. Speedy LS-07-178

Caryophyllaceae
Agrostemma githago L., 1957 M.S. Lewis s.n. Europe
Arenaria serpyllifolia L. var. *serpyllifolia*, 1913 J. Bright s.n. Europe
Cerastium fontanum Baumg. ssp. *vulgare*, 2009 L. Speedy 09-610 Eurasia
Cerastium nutans Raf. var. *nutans*, 1942 O.E. Jennings s.n.
Cerastium tomentosum L., 1976 J.E. Kassulke s.n. Europe
Dianthus armeria L., 2009 L. Speedy 09-622 Europe
Dianthus barbatus L., 1973 W.E. Buker s.n. Eurasia
Moehringia lateriflora (L.) Fenzl, 2009 L. Speedy 09-0236
Myosoton aquaticum (L.) Moench, 2007 L. Speedy 07-576 Europe
Paronychia canadensis (L.) Wood, 2009 L. Speedy 09-648
Saponaria officinalis L., 1995 F.H. Utech 95-904 Europe
Silene latifolia Poir., 2009 L. Speedy 09-0582 Europe
Silene noctiflora L., 1946 H. Roslund s.n. Europe
Silene stellata (L.) Ait. f., 2008 L. Speedy 08-1036
Silene virginica L., 2009 L. Speedy 09-0156
Silene vulgaris (Moench) Garcke, 2009 L. Speedy 09-0445 Europe
Stellaria alsine Grimm, 1982 M. Cipollini s.n.
Stellaria graminea L., 1952 L.K. Henry and F.H. Beer s.n. Europe
Stellaria longifolia Muhl. ex Willd., 2009 L. Speedy 09-0232
Stellaria media (L.) Vill., 2008 L. Speedy 08-1064 Europe
Stellaria pubera Michx., 2007 L. Speedy LS-07-75

Celastraceae
Celastrus orbiculatus Thunb., 2008 L. Speedy 08-388F Japan and China
Celastrus scandens L., 2009 L. Speedy 09-589
Euonymus atropurpureus Jacq. var. *atropurpureus*, 1942 O.E. Jennings s.n.

Ceratophyllaceae
Ceratophyllum demersum L., 1984 M. Polechko s.n.

Chenopodiaceae
Chenopodium album L. var. *album*, 1952 L.K. Henry and F.H. Beer s.n.

Cistaceae
Lechea racemulosa Michx., 1901 J.A. Shafer s.n.

Clusiaceae
Hypericum ellipticum Hook., 1908 O.E. Jennings s.n.
Hypericum gentianoides (L.) B.S.P., 1959 H. Bell s.n.
Hypericum mutilum L., 2008 L. Speedy and M. Bowers 08-915
Hypericum perforatum L., 2009 L. Speedy 09-804 Europe
Hypericum prolificum L., 2007 L. Speedy, C. Tracey and S. Stewart 07-1012
Hypericum punctatum Lam., 2009 L. Speedy 09-915
Triadenum fraseri (Spach) Gleason, 2008 L. Speedy 08-1252

Commelinaceae
Commelina communis L., 2008 L. Speedy 08-1034 Asia

Convolvulaceae
Calystegia sepium (L.) R. Br. ssp. *americana*, 2009 L. Speedy 09-629
Calystegia spithamaea (L.) Pursh, 1946 H.A. Wahl 1904
Convolvulus arvensis L., 1982 M. Cipollini s.n. Europe
Ipomoea pandurata (L.) G.F.W. Mey., 1901 J.A. Shafer s.n.

Cornaceae
Cornus alternifolia L. f., 2008 L. Speedy 08-387
Cornus amomum P. Mill., 2007 L. Speedy 07-789
Cornus canadensis L., 1954 F. Streams s.n.
Cornus florida L., 2008 L. Speedy 08-0186
Cornus obliqua Raf., 1952 L.K. Henry and F.H. Beer s.n. [*Cornus amomum* P. Mill. ssp. *obliqua* (Raf.) J.S. Wilson]
Cornus racemosa Lam., 2009 L. Speedy 09-0545
Nyssa sylvatica Marsh., 2008 L. Speedy 08-1285

Crassulaceae
Penthorum sedoides L., 2008 L. Speedy 08-894
Sedum ternatum Michx., 2008 L. Speedy 08-1067

Cucurbitaceae
Echinocystis lobata (Michx.) Torr. & A. Gray, 2009 L. Speedy 09-793
Sicyos angulatus L., 2007 L. Speedy 07-1797

Cuscutaceae
Cuscuta gronovii Willd. ex J.A. Schultes var. *gronovii*, 2008 L. Speedy 08-1298

Cyperaceae
Bulbostylis capillaris (L.) Kunth ex C.B. Clarke, 1995 F.H. Utech 95-903
Carex albicans Willd. ex Spreng. var. *albicans*, 1946 L.K. Henry s.n. [*Carex artitecta* Mackenzie]
Carex albursina Sheldon, 2008 L. Speedy 08-402
Carex amphibola Steud., 2008 L. Speedy 08-613
Carex annectens (Bickn.) Bickn., 1954 F. Streams s.n.
Carex appalachica J. Webber & P.W. Ball, 2009 L. Speedy 09-0275
Carex atlantica Bailey ssp. *atlantica*, 2007 L. Speedy and M. Bowers 07-873
Carex baileyi Britt., 2009 L. Speedy 09-0455
Carex blanda Dewey, 2008 L. Speedy 08-673
Carex bromoides Schkuhr ex Willd. ssp. *bromoides*, 2009 L. Speedy 09-0552
Carex brunnescens (Pers.) Poir. ssp. *sphaerostachya*, 1995 J.D. Wagner and L.L. Smith 942
Carex caroliniana Schwein., 1952 L.K. Henry and F.H. Beer s.n.
Carex cephalophora Muhl. ex Willd., 2009 L. Speedy 09-776
Carex communis Bailey var. *communis*, 2009 L. Speedy 09-613
Carex crinita Lam. var. *crinita*, 2007 L. Speedy 07-554
Carex debilis Michx. var. *rudgei*, 2009 L. Speedy 09-673
Carex digitalis Willd. var. *digitalis*, 2009 L. Speedy 09-0433
Carex gracilescens Steud., 2007 L. Speedy 07-508
Carex gracillima Schwein., 2009 L. Speedy 09-0554
Carex granularis Muhl. ex Willd., 2007 L. Speedy 07-880
Carex grayi Carey, 2009 L. Speedy 09-0570
Carex grisea Wahlenb., 1993 W.A. Zanol 1579
Carex gynandra Schwein., 2009 L. Speedy 09-822
Carex hirsutella Mackenzie, 2009 L. Speedy 09-639
Carex hirtifolia Mackenzie, 1946 L.K. Henry s.n.
Carex intumescens Rudge, 2008 L. Speedy 08-575
Carex laevivaginata (Kukenth.) Mackenzie, 1942 C.E. Wood 2087
Carex laxiculmis Schwein. var. *copulata*, 2008 L. Speedy 08-612
Carex laxiculmis Schwein. var. *laxiculmis*, 2009 L. Speedy 09-0546
Carex laxiflora Lam., 2009 L. Speedy 09-0456
Carex leptonervia (Fern.) Fern., 1950 L.K. Henry and F.H. Beer s.n.
Carex lupulina Muhl. ex Willd., 2007 L. Speedy 07-555
Carex lurida Wahlenb., 2009 L. Speedy 09-0548
Carex normalis Mackenzie, 1946 L.K. Henry s.n.
Carex pensylvanica Lam., 2009 L. Speedy 09-0560
Carex plantaginea Lam., 2009 L. Speedy 09-619
Carex prasina Wahlenb., 2009 L. Speedy 09-0581
Carex projecta Mackenzie, 2009 L. Speedy 09-0571
Carex radiata (Wahlenb.) Small, 2009 L. Speedy 09-784
Carex rosea Schkuhr ex Willd., 2009 L. Speedy and C. Rogers 09-592 [*Carex convoluta* Mackenzie]
Carex scabrata Schwein., 2008 L. Speedy 08-994
Carex scoparia Schkuhr ex Willd. var. *scoparia*, 2009 L. Speedy 09-0562
Carex sparganioides Muhl. ex Willd., 1945 O.E. Jennings s.n.
Carex squarrosa L., 2008 L. Speedy 08-880
Carex stipata Muhl. ex Willd. var. *stipata*, 2009 L. Speedy 09-0566
Carex stricta Lam., 2009 L. Speedy 09-0579
Carex swanii (Fern.) Mackenzie, 2009 L. Speedy 09-0576
Carex torta Boott ex Tuckerman, 2009 L. Speedy 09-0233
Carex tribuloides Wahlenb. var. *tribuloides*, 2008 L. Speedy 08-666
Carex trisperma Dewey, 2007 L. Speedy LS-07-451
Carex virescens Muhl. ex Willd., 2009 L. Speedy and C. Rogers 09-597
Carex vulpinoidea Michx., 2009 L. Speedy 09-0563
Carex woodii Dewey, 1952 L.K. Henry and F.H. Beer s.n.
Cyperus dentatus Torr., 2008 L. Speedy and M. Bowers 08-930
Cyperus esculentus L., 1974 P. Herr s.n.
Cyperus strigosus L., 2007 L. Speedy, C. Tracey and S. Stewart 07-994
Dulichium arundinaceum (L.) Britt. var. *arundinaceum*, 2007 L. Speedy, C. Tracey and S. Stewart 07-995
Eleocharis acicularis (L.) Roemer & J.A. Schultes, 2007 L. Speedy, C. Tracey and S. Stewart 07-989
Eleocharis obtusa (Willd.) J.A. Schultes, 2009 L. Speedy 09-924
Eleocharis palustris (L.) Roemer & J.A. Schultes, 2009 L. Speedy 09-0573 [*Eleocharis erythropoda* Steud.]
Eleocharis tenuis (Willd.) J.A. Schultes var. *tenuis*, 2009 L. Speedy 09-0279
Schoenoplectus pungens (Vahl) Palla var. *pungens*, 2008 L. Speedy and M. Bowers 08-932
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, 2009 L. Speedy 09-0574 [*Scirpus validus* Vahl]
Scirpus cyperinus (L.) Kunth, 2009 L. Speedy 09-907
Scirpus hattorianus Makino, 1952 L.K. Henry and F.H. Beer s.n.
Scirpus polyphyllus Vahl, 2008 L. Speedy 08-1213

Dioscoreaceae
Dioscorea villosa L., 2008 L. Speedy 08-428 [*Dioscorea quaternata* J.F. Gmel]

Dipsacaceae

Dipsacus fullonum L., 1965 A.G. Shields s.n. Europe

Elaegnaceae

Elaeagnus umbellata Thunb., 2008 L. Speedy 08-375 Asia

Ericaceae

Epigaea repens L., 2009 L. Speedy 09-0440
Gaultheria procumbens L., 2008 L. Speedy 08-964
Gaylussacia baccata (Wangenh.) K. Koch, 2008 L. Speedy 08-435
Kalmia latifolia L., 2009 L. Speedy 09-0439
Rhododendron maximum L., 2008 L. Speedy 08-958
Rhododendron periclymenoides (Michx.) Shinners, 2008 L. Speedy 08-341
Rhododendron prinophyllum (Small) Millais, 2009 L. Speedy 09-0164
Vaccinium angustifolium Ait., 2007 L. Speedy and C. Tracey LS-07-333
Vaccinium macrocarpon Ait., 2008 L. Speedy 08-709
Vaccinium pallidum Ait., 2009 L. Speedy 09-643
Vaccinium stamineum L., 2008 L. Speedy 08-973

Euphorbiaceae

Acalypha rhomboidea Raf., 2008 L. Speedy 08-1198
Chamaesyce maculata (L.) Small, 1944 O.E. Jennings s.n. [*Euphorbia maculata* L.]
Chamaesyce nutans (Lag.) Small, 2008 L. Speedy 08-911 [*Euphorbia nutans* Lag.]
Chamaesyce vermiculata (Raf.) House, 1994 W.A. Zanol 3520 [*Euphorbia vermiculata* Raf.]
Euphorbia corollata L., 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-826
Euphorbia cyparissias L., 1948 M.S. Lewis s.n. Eurasia
Euphorbia dentata Michx. var. *dentata*, 2008 L. Speedy 08-1181

Fabaceae

Amphicarpaea bracteata (L.) Fern. var. *bracteata*, 2008 L. Speedy 08-1030
Apios americana Medik., 2009 L. Speedy 09-788
Baptisia tinctoria (L.) R. Br. ex Ait. f., 1946 L.K. Henry s.n.
Cercis canadensis L. var. *canadensis*, 2007 L. Speedy 07-1802
Chamaecrista nictitans (L.) Moench, 1947 M.S. Lewis s.n.
Desmodium canadense (L.) DC., 2008 L. Speedy 08-976
Desmodium glutinosum (Muhl. ex Willd.) Wood, 2008 L. Speedy 08-810
Desmodium nudiflorum (L.) DC., 1951 W.E. Buker and F.H. Beer s.n.
Desmodium paniculatum (L.) DC., 2007 L. Speedy 07-1101
Desmodium perplexum Schub., 1943 O.E. Jennings s.n.
Gleditsia triacanthos L., 1985 J. Woodle s.n.
Lathyrus latifolius L., 2009 L. Speedy 09-677 Europe
Lespedeza frutescens (L.) Hornem., 2009 L. Speedy 09-0426 [*Lespedeza intermedia* (S. Wats.) Britt.]
Lotus corniculatus L., 2009 L. Speedy 09-621 Europe
Medicago lupulina L., 1994 B.L. Isaac and J.A. Isaac 6842 Eurasia
Medicago sativa L. ssp. *sativa*, 1990 F.H. Utech 90-1237 Eurasia
Melilotus officinalis (L.) Lam., 2009 L. Speedy 09-0423 Eurasia
Robinia pseudoacacia L., 2009 L. Speedy 09-800
Securigera varia (L.) Lassen, 2007 L. Speedy, C. Tracey and S. Stewart 07-1001 Europe
Senna hebecarpa (Fern.) Irwin & Barneby, 1965 A.G. Shields s.n.
Tephrosia virginiana (L.) Pers., 1901 J.A. Shafer s.n.
Trifolium aureum Pollich, 1946 L.K. Henry s.n. Eurasia
Trifolium campestre Schreb., 1993 W.A. Zanol 1590 Europe
Trifolium hybridum L., 1994 S.A. Thompson 11702 Eurasia
Trifolium pratense L., 1994 S.A. Thompson 11700 Europe
Trifolium repens L., 1994 B.L. Isaac and J.A. Isaac 6879 Europe
Vicia villosa Roth ssp. *villosa*, 1945 O.E. Jennings s.n. Europe
Wisteria frutescens (L.) Poir., 1983 A. Hines s.n.

Fagaceae

Castanea dentata (Marsh.) Borkh., 2007 L. Speedy 07-1678
Fagus grandifolia Ehrh., 2008 L. Speedy 08-0284
Quercus alba L., 2009 L. Speedy 09-1085-1
Quercus bicolor Willd., 2008 L. Speedy 08-0140-2
Quercus coccinea Muenchh., 2008 L. Speedy and D. White 08-1245
Quercus ilicifolia Wangenh., 1948 D.P. Caylor s.n.
Quercus imbricaria Michx., 2009 L. Speedy 09-0218
Quercus montana Willd., 2009 L. Speedy 09-1088 [*Quercus prinus* L.]
Quercus rubra L., 2008 L. Speedy 08-674
Quercus velutina Lam., 1937 O.E. Jennings s.n.
Quercus × *leana* Nutt. (pro sp.), 2007 L. Speedy and G. Davis 07-1836-1

Fumariaceae

Capnoides sempervirens (L.) Borkh., 1968 A.G. Shields s.n. [*Corydalis sempervirens* (L.) Pers.]
Corydalis flavula (Raf.) DC., 2008 L. Speedy 08-0049
Dicentra canadensis (Goldie) Walp., 2007 L. Speedy and C. Tracey LS-07-139
Dicentra cucullaria (L.) Bernh., 2008 L. Speedy 08-0061

Gentianaceae

Bartonia virginica (L.) B.S.P., 1947 L.K. Henry s.n.
Gentiana andrewsii Griseb. var. *andrewsii*, 1957 L.K. Henry s.n.
Gentiana clausa Raf., 2009 L. Speedy 09-1007
Sabatia angularis (L.) Pursh, 1901 C.R. Holmes s.n.

Geraniaceae

Geranium maculatum L., 2009 L. Speedy 09-0241

Grossulariaceae

Ribes cynosbati L., 2008 L. Speedy 08-944
Ribes rubrum L., 2009 L. Speedy 09-0225 Eurasia

Haloragaceae

Myriophyllum spicatum L., 2008 L. Speedy, J.A. Isaac, B.L. Isaac and BSWP 08-1025 Eurasia

Hamamelidaceae

Hamamelis virginiana L., 2009 L. Speedy 09-1098

Hydrangeaceae

Hydrangea arborescens L., 2008 L. Speedy 08-524

Hydrocharitaceae

Elodea canadensis Michx., 2007 L. Speedy, C. Tracey and E. Trexler 07-965
Elodea nuttallii (Planch.) St. John, 2008 L. Speedy and M. Bowers 08-926
Vallisneria americana Michx., 2008 L. Speedy and M. Bowers 08-934

Hydrophyllaceae

Hydrophyllum canadense L., 1957 M.S. Lewis s.n.
Hydrophyllum virginianum L. var. *virginianum*, 2008 L. Speedy 08-400

Iridaceae

Iris pseudacorus L., 2007 L. Speedy and C. Tracey 07-1518 Europe
Iris versicolor L., 1957 M.S. Lewis s.n.
Sisyrinchium angustifolium P. Mill., 2009 L. Speedy 09-666

Juglandaceae

Carya alba (L.) Nutt. ex Ell., 1946 H.A. Wahl 1650 [*Carya tomentosa* (Lam. ex Poir.) Nutt.]
Carya cordiformis (Wangenh.) K. Koch, 2008 L. Speedy 08-389H
Carya glabra (P. Mill.) Sweet, 2008 L. Speedy 08-1039-2 [*Carya ovalis* (Wangenh.) Sarg.]
Carya ovata (P. Mill.) K. Koch, 2009 L. Speedy 09-809-1
Juglans cinerea L., 1952 L.K. Henry and F.H. Beer s.n.
Juglans nigra L., 1993 W.A. Zanol 1597

Juncaceae
Juncus acuminatus Michx., 2009 L. Speedy 09-0578
Juncus articulatus L., 2008 L. Speedy 08-1149
Juncus bufonius L., 1908 O.E. Jennings s.n.
Juncus canadensis J. Gay ex Laharpe, 2009 L. Speedy 09-925
Juncus dudleyi Wieg., 2007 L. Speedy LS-07-441

Juncus effusus L. ssp. *pylaei*, 2009 L. Speedy 09-920 [*Juncus effusus* L. var. *pylaei* (Laharpe) Fern. & Wieg.]
Juncus effusus L. ssp. *solutus*, 2008 L. Speedy 08-1325
Juncus marginatus Rostk., 2008 L. Speedy 08-1317
Juncus subcaudatus (Engelm.) Coville & Blake var. *subcaudatus*, 2008 L. Speedy 08-1175
Juncus tenuis Willd., 2009 L. Speedy 09-0555
Luzula acuminata Raf. ssp. *acuminata*, 2009 L. Speedy 09-672
Luzula multiflora (Ehrh.) Lej. ssp. *multiflora* var. *multiflora*, 2009 L. Speedy 09-0235

Lamiaceae
Ajuga reptans L., 1970 D. Pifer s.n. Eurasia
Blephilia hirsuta (Pursh) Benth. var. *hirsuta*, 2009 L. Speedy 09-650
Clinopodium vulgare L., 1994 B.L. Isaac and J.A. Isaac 6873 [*Satureia vulgaris* (L.) Fritsch]
Collinsonia canadensis L., 2008 L. Speedy 08-1029
Galeopsis bifida Boenn., 2008 L. Speedy 08-1303 Eurasia
Glechoma hederacea L., 2008 L. Speedy 08-347 Eurasia
Hedeoma pulegioides (L.) Pers., 2009 L. Speedy 09-1097
Lamium purpureum L., 1970 A.G. Shields s.n. Eurasia
Leonurus cardiaca L., 1965 A.G. Shields s.n. Asia
Lycopus americanus Muhl. ex W. Bart., 1952 L.K. Henry and F.H. Beer s.n.
Lycopus uniflorus Michx. var. *uniflorus*, 2008 L. Speedy 08-1173
Lycopus virginicus L., 2008 L. Speedy 08-1207
Mentha ×*piperita* L. (pro sp.), 1968 A.G. Shields s.n. Eurasia
Mentha spicata L., 1995 F.H. Utech 95-876 Europe
Mentha × *villosa* Huds. (pro sp.), 2009 L. Speedy 09-808 Eurasia
Monarda clinopodia L., 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-796
Monarda didyma L., 2009 L. Speedy 09-789
Monarda fistulosa L. ssp. *fistulosa* var. *fistulosa*, 2009 L. Speedy 09-781
Monarda media Willd., 2008 L. Speedy 08-908
Nepeta cataria L., 1901 J.A. Shafer s.n. Eurasia
Physostegia virginiana (L.) Benth. ssp. *virginiana*, 2008 L. Speedy 08-1161
Prunella vulgaris L. ssp. *lanceolata*, 1994 W.A. Zanol 3530
Prunella vulgaris L. ssp. *vulgaris*, 1990 F.H. Utech 90-1233 Europe
Pycnanthemum incanum (L.) Michx. var. *incanum*, 2008 L. Speedy 08-1044
Pycnanthemum tenuifolium Schrad., 1901 J.A. Shafer s.n.
Pycnanthemum verticillatum (Michx.) Pers. var. *verticillatum*, 1954 L.K. Henry and W.E. Buker s.n.
Scutellaria incana Biehler var. *incana*, 2009 L. Speedy 09-786
Scutellaria lateriflora L. var. *lateriflora*, 2008 L. Speedy 08-903
Scutellaria nervosa Pursh, 2009 L. Speedy 09-0237
Stachys palustris L. var. *palustris*, 1951 E.T. Wherry s.n.
Teucrium canadense L. var. *canadense*, 2009 L. Speedy 09-790 [*Teucrium* canadense var. *virginicum* (L.) Eat.]
Trichostema dichotomum L., 1966 J. Peterson s.n.

Lauraceae
Lindera benzoin (L.) Blume, 2008 L. Speedy 08-507
Sassafras albidum (Nutt.) Nees, 2008 L. Speedy 08-0171

Lemnaceae
Lemna minor L., 2009 L. Speedy 09-1011

Liliaceae
Allium canadense L. var. *canadense*, 2007 L. Speedy and C. Porter 07-[illegible]
Allium cernuum Roth, 2008 L. Speedy 08-1053
Allium tricoccum Ait., 2008 L. Speedy 08-[illegible]
Allium vineale L. ssp. *vineale*, 1981 F.H. Utech 81-050 Europe
Asparagus officinalis L., 1967 J. Gelsdorf s.n. Europe
Chamaelirium luteum (L.) A. Gray, 1942 W.H. Wagner 728
Clintonia umbellulata (Michx.) Morong, 2008 L. Speedy 08-521
Convallaria majalis L., 1949 E.M. McCallister s.n. Europe
Erythronium americanum Ker Gawl. ssp. *americanum*, 2008 L. Speedy 08-0113
Hemerocallis fulva (L.) L., 1994 S.A. Thompson 11699 Asia
Hypoxis hirsuta (L.) Coville, 1942 R.W. Pohl 3802
Lilium canadense L., 1982 J. Humphreys s.n.
Lilium philadelphicum L., 1957 J. Mash s.n.
Lilium superbum L., 1954 L.K. Henry and W.E. Buker s.n.
Maianthemum canadense Desf., 2008 L. Speedy 08-456
Maianthemum racemosum (L.) Link ssp. *racemosum*, 2007 L. Speedy LS-07-354 [*Smilacina racemosa* (L.) Desf.]
Medeola virginiana L., 2009 L. Speedy 09-0450
Muscari botryoides (L.) P. Mill., 1967 R.K. Riley s.n. Europe
Polygonatum biflorum (Walt.) Ell. var. *commutatum*, 2009 L. Speedy 09-794
Polygonatum pubescens (Willd.) Pursh, 2008 L. Speedy 08-349
Prosartes lanuginosa (Michx.) D. Don, 2009 L. Speedy 09-0158 [*Disporum lanuginosum* (Michx.) Nichols.]
Stenanthium gramineum (Ker-Gawl.) Morong, 2008 L. Speedy 08-1010 **G4G5:S1S2**
Streptopus lanceolatus (Ait.) Reveal var. *lanceolatus*, 2007 L. Speedy LS-07-299 [*Streptopus roseus* Michx. var. *perspectus* Fassett]
Trillium erectum L., 2009 L. Speedy 09-0103 [*Trillium erectum* var. *album* (Michx.) Pursh]
Trillium flexipes Raf., 1952 L.K. Henry and F.H. Beer s.n. **G5:S2**
Trillium grandiflorum (Michx.) Salisb., 2008 L. Speedy 08-0281
Trillium sessile L., 1946 L.K. Henry s.n.
Trillium undulatum Willd., 2008 L. Speedy 08-573
Uvularia perfoliata L., 2008 L. Speedy 08-0164
Uvularia sessilifolia L., 2009 L. Speedy 09-0281
Veratrum latifolium (Desr.) Zomlefer, 1952 L.K. Henry and F.H. Beer s.n. [*Melanthium latifolium* Desr.]
Veratrum viride Ait. var. *viride*, 2008 L. Speedy 08-396

Limnanthaceae
Floerkea proserpinacoides Willd., 2008 L. Speedy 08-0117

Linaceae
Linum striatum Walt., 2009 L. Speedy 09-658
Linum usitatissimum L., 1901 J.A. Shafer s.n. Europe

Lythraceae
Cuphea viscosissima Jacq., 1990 F.H. Utech 90-1235
Lythrum salicaria L., 2009 L. Speedy 09-810 Europe

Magnoliaceae
Liriodendron tulipifera L., 2009 L. Speedy 09-0143
Magnolia acuminata (L.) L., 2008 L. Speedy 08-969

Malvaceae
Abutilon theophrasti Medik., 1968 A.G. Shields s.n. Asia
Malva moschata L., 1982 M. Cipollini s.n. Europe
Malva neglecta Wallr., 1976 D. Cunkelman s.n. Eurasia

Monotropaceae
Monotropa hypopithys L., 1963 A. Ward s.n.
Monotropa uniflora L., 2008 L. Speedy 08-957

Moraceae
Morus alba L., 2007 D. Schneider s.n. [illegible]

Najadaceae
Najas flexilis (Willd.) Rostk. & Schmidt, 1984 M. Polechko s.n.
Najas gracillima (A. Braun ex Engelm.) Magnus, 2007 L. Speedy, C. Tracey and E. Trexler 07-967 **G5?:S4**

Nyctaginaceae
Mirabilis jalapa L., 1965 F. Swalga s.n. Tropical America
Mirabilis nyctaginea (Michx.) MacM., 1958 J.E. Belles s.n.

Nymphaeaceae
Nuphar advena (Ait.) Ait. F. ssp. *advena*, 1984 M. Polechko s.n. [*Nuphar advena* (Ait.) Ait. f.]
Nymphaea odorata Ait. ssp. *odorata*, 2007 L. Speedy, C. Tracey and S. Stewart 07-990

Oleaceae
Fraxinus americana L., 2008 L. Speedy 08-1211
Fraxinus nigra Marsh., 1954 L.K. Henry and W.E. Buker s.n.
Fraxinus pennsylvanica Marsh., 2007 L. Speedy and C. Tracey 07-1497
Ligustrum obtusifolium Sieb. & Zucc., 2008 L. Speedy 08-513 Japan

Onagraceae
Chamerion angustifolium (L.) Holub ssp. *circumvagum*, 1908 O.E. Jennings s.n.
Circaea alpina L. ssp. *alpina*, 2008 L. Speedy [illegible]
Circaea canadensis (L.) Hill, 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-795 [*Circaea lutetiana* L. ssp. *canadensis* (L.) Aschers. & Magnus]
Epilobium ciliatum Raf. ssp. *ciliatum*, 2008 L. Speedy 08-1125
Epilobium coloratum Biehler, 2009 L. Speedy 09-896
Epilobium hirsutum L., 2009 L. Speedy 09-1019 Europe
Ludwigia alternifolia L., 2009 L. Speedy [illegible]
Ludwigia palustris (L.) Ell., 2009 L. Speedy [illegible]
Oenothera biennis L., [illegible]
Oenothera fruticosa L. ssp. *glauca*, 2007 L. Speedy [illegible]
Oenothera parviflora L., 2008 L. Speedy 08-1321-2
Oenothera perennis L., 2009 L. Speedy 09-612
Oenothera villosa Thunb. ssp. *villosa*, 2009 L. Speedy 09-805

Orchidaceae
Corallorhiza maculata (Raf.) Raf., 1974 W.E. Buker s.n.
Corallorhiza odontorhiza (Willd.) Poir., 1996 J.S. Shriver, A. Shriver and C. Smith 756
Cypripedium acaule Ait., 2007 L. Speedy LS-07-356
Cypripedium parviflorum Salisb. var. *pubescens*, 1947 M.S. Lewis s.n [*Cypripedium calceolus* var. *pubescens* (Willd.) Correll]
Epipactis helleborine (L.) Crantz, 2009 L. Speedy 09-618 Europe
Galearis spectabilis (L.) Raf., 1904 O.E. Jennings s.n.
Goodyera pubescens (Willd.) R. Br. ex Ait. f., 2009 L. Speedy 09-608
Isotria verticillata Raf., 1968 J. Rummel s.n.
Liparis liliifolia (L.) L.C. Rich ex Ker-Gawl., 1942 W.H. Wagner 720
Liparis loeselii (L.) L.C. Rich., 1968 A.G. Shields s.n.
Platanthera fissa (R. Br.) Lindl., 2002 B. Poglein s.n. [*Habenaria peramoena* A. Gray]
Platanthera flava (L.) Lindl. var. *flava*, 2009 L. Speedy 09-656
Platanthera grandiflora (Bigelow) Lindl., 1908 O.E. Jennings s.n.
Platanthera lacera (Michx.) G. Don, 1946 L.K. Henry s.n.
Platanthera orbiculata (Pursh) Lindl., 1961 J. Mash s.n.
Spiranthes cernua (L.) L.C. Rich., 2008 L. Speedy 08-1315
Spiranthes lacera (Raf.) Raf. var. *gracilis*, 1952 L.K. Henry and F.H. Beer s.n.
Spiranthes ochroleuca (Rydb.) Rydb., 1996 J.S. Shriver, A. Shriver and C. Smith 755

Orobanchaceae
Conopholis americana (L.) Wallr., 2009 L. Speedy 09-0434
Epifagus virginiana (L.) W. Bart., 2009 L. Speedy 09-1084
Orobanche uniflora L., 2008 L. Speedy 08-0180

Oxalidaceae
Oxalis grandis Small, 1945 O.E. Jennings s.n.
Oxalis montana Raf., 2008 L. Speedy 08-626 [*Oxalis acetosella* auct. non L.]
Oxalis stricta L., 2007 L. Speedy LS-07-439
Oxalis violacea L., 2009 L. Speedy 09-0239

Papaveraceae
Chelidonium majus L. var. *majus*, 2008 L. Speedy 08-391 Eurasia
Sanguinaria canadensis L., 2008 L. Speedy 08-0058

Phytolaccaceae
Phytolacca americana L. var. *americana*, 2008 L. Speedy 08-954

Plantaginaceae
Plantago lanceolata L., 2009 L. Speedy 09-659 Europe
Plantago major L., 1982 M. Cipollini s.n. Europe
Plantago rugelii Dcne., 1994 B.L. Isaac and J.A. Isaac 6792
Plantago virginica L., 1904 O.E. Jennings s.n.

Platanaceae
Platanus occidentalis L., 2008 L. Speedy 07-1795-1

Poaceae
Agrostis gigantea Roth, 2009 L. Speedy 09-929 Europe
Agrostis perennans (Walt.) Tuckerman, 2009 L. Speedy 09-1094
Agrostis scabra Willd., 2009 L. Speedy 09-914
Agrostis stolonifera L., 2008 L. Speedy 08-389A Europe
Andropogon gerardii Vitman, 2008 L. Speedy 08-1294
Andropogon glomeratus (Walt.) B.S.P. var. *glomeratus*, 2009 L. Speedy and B. Poglein 09-861 **G5:S3** [*Andropogon virginicus* L. var. *abbreviatus* (Hack.) Fern. & Grisc.]
Andropogon virginicus L. var. *virginicus*, 2007 L. Speedy 07-1792
Anthoxanthum odoratum L., 2009 L. Speedy 09-607 Eurasia
Aristida dichotoma Michx., 1972 B. Dunn s.n.
Arrhenatherum elatius (L.) Beauv. ex J. & K. Presl var. *elatius*, 2008 L. Speedy 08-627 Europe
Brachyelytrum aristosum (Michx.) Beauv. ex Branner & Coville, 2009 L. Speedy 09-616
Brachyelytrum erectum (Schreb. ex Spreng.) Beauv., 2008 L. Speedy and D. White 08-1241
Bromus arvensis L., 2008 L. Speedy 08-512 Southern Europe
Bromus ciliatus L., 1946 L.K. Henry s.n.
Bromus inermis Leyss., 2009 L. Speedy 09-0435 Europe
Bromus latiglumis (Scribn. ex Shear) A.S. Hitchc., 2008 L. Speedy 08-790 [*Bromus altissimus* Pursh]
Bromus pubescens Muhl. ex Willd., 2009 L. Speedy 09-780
Bromus racemosus L., 2009 L. Speedy 09-0425 Europe
Cinna arundinacea L., 2009 L. Speedy 09-913
Cinna latifolia (Trev. ex Goepp.) Griseb., 2009 L. Speedy 09-1005
Dactylis glomerata L. ssp. *glomerata*, 2008 L. Speedy 08-628 Europe
Danthonia compressa Austin, 2009 L. Speedy and C. Rogers 09-596
Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, 2009 L. Speedy 09-646
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, 2008 L. Speedy 08-691 [*Panicum acuminatum* Sw.]
Dichanthelium boscii (Poir.) Gould & C.A. Clark, 2009 L. Speedy 09-814 [*Panicum boscii* Poir.]
Dichanthelium clandestinum (L.) Gould, 2008 L. Speedy 08-1291 [*Panicum clandestinum* L.]
Dichanthelium commutatum (J.A. Schultes) Gould, 2009 L. Speedy 09-660 [*Panicum commutatum* J.A. Schultes]
Dichanthelium depauperatum (Muhl.) Gould, 1942 C.E. Wood 2095

Dichanthelium dichotomum (L.) Gould var. *dichotomum*, 2009 L. Speedy 09-654 [*Panicum dichotomum* L.]
Dichanthelium latifolium (L.) Harville, 2009 L. Speedy and C. Rogers 09-591 [*Panicum latifolium* L.]
Dichanthelium linearifolium (Scribn. ex Nash) Gould, 2009 L. Speedy 09-0429 [*Panicum linearifolium* Scribn. ex Nash]
Dichanthelium portoricense (Desv. Ex Hamilton) B.F. Hansen & Wunderlin, 1937 O.E. Jennings s.n. [*Panicum sphaerocarpon* Ell.]
Dichanthelium sabulorum (Lam.) Gould & C.A. Clark var. *thinium*, 2009 L. Speedy 09-777
Digitaria ischaemum (Schreb. ex Schweig.) Schreb. ex Muhl., 2009 L. Speedy 09-802 Eurasia
Digitaria sanguinalis (L.) Scop., 1995 F.H. Utech 95-880 Europe
Echinochloa crus-galli (L.) Beauv., 2008 L. Speedy and M. Bowers 08-1304 Eurasia
Echinochloa muricata (Beauv.) Fern. var. *muricata*, 2007 L. Speedy, C. Tracey and S. Stewart 07-998 Eurasia
Elymus hystrix L. var. *hystrix*, 2008 L. Speedy 08-777 [*Hystrix patula* Moench]
Elymus repens (L.) Gould, 2009 L. Speedy 09-931 Eurasia
Elymus riparius Wieg., 2008 L. Speedy 08-1146
Elymus villosus Muhl. ex Willd., 2008 L. Speedy 08-888
Elymus virginicus L. var. *virginicus*, 2009 L. Speedy 09-779
Elymus × *ebingeri* G. Tucker, 2008 L. Speedy 08-700
Eragrostis capillaris (L.) Nees, 2008 L. Speedy 08-1077
Eragrostis hypnoides (Lam.) B.S.P., 1952 L.K. Henry and F.H. Beer s.n.
Eragrostis minor Host, 1995 F.H. Utech 95-875 Europe
Eragrostis pectinacea (Michx.) Nees ex Jedw. var. *pectinacea*, 2009 L. Speedy 09-799
Eragrostis spectabilis (Pursh) Steud., 1995 F.H. Utech 95-897
Festuca arundinacea Schreb., 2009 L. Speedy 09-0420 Europe
Festuca pratensis Huds., 1945 O.E. Jennings s.n. Europe
Festuca subverticillata (Pers.) Alexeev, 2009 L. Speedy 09-670 [*Festuca obtusa* Biehler]
Glyceria canadensis (Michx.) Trin., 2007 L. Speedy, C. Tracey and S. Stewart 07-997
Glyceria melicaria (Michx.) F.T. Hubbard, 2009 L. Speedy and C. Rogers 09-1081
Glyceria striata (Lam.) A.S. Hitchc., 2009 L. Speedy 09-0549
Holcus lanatus L., 2009 L. Speedy 09-0557 Europe
Hordeum jubatum L., 1982 R.P. Bloom s.n.
Leersia oryzoides (L.) Sw., 2009 L. Speedy 09-926
Leersia virginica Willd., 2008 L. Speedy 08-1324
Lolium perenne L. ssp. *multiflorum*, 2009 L. Speedy 09-626 Europe
Microstegium vimineum (Trin.) A. Camus, 2008 L. Speedy 08-1346 Tropical Asia
Milium effusum L. var. *cisatlanticum*, 1965 A.G. Shields s.n.
Muhlenbergia frondosa (Poir.) Fern., 1942 O.E. Jennings s.n.
Muhlenbergia schreberi J.F. Gmel., 2009 L. Speedy 09-930
Muhlenbergia sobolifera (Muhl. ex Willd.) Trin., 2008 L. Speedy 08-1049
Muhlenbergia sylvatica (Torr.) Torr. ex A. Gray, 2008 L. Speedy 08-1142
Muhlenbergia tenuiflora (Willd.) B.S.P., 2009 L. Speedy 09-1090
Panicum capillare L., 1995 F.H. Utech 95-882
Panicum dichotomiflorum Michx. var. *dichotomiflorum*, 2008 L. Speedy 08-1343
Panicum gattingeri Nash, 2007 L. Speedy 07-1686
Panicum rigidulum Bosc ex Nees var. *rigidulum*, 2009 L. Speedy and B. Poglein 09-847
Panicum verrucosum Muhl., 2008 L. Speedy and M. Bowers 08-1271
Panicum virgatum L. var. *virgatum*, 2008 L. Speedy 08-1006
Phalaris arundinacea L., 2008 L. Speedy 08-625
Phleum pratense L., 2009 L. Speedy 09-630 Europe
Phragmites australis (Cav.) Trin. ex Steud., 1982 G. Yakub s.n.
Poa alsodes A. Gray, 2009 L. Speedy 09-0207
Poa compressa L., 2009 L. Speedy 09-0421 Europe
Poa cuspidata Nutt., 1946 L.K. Henry s.n.
Poa palustris L., 2009 L. Speedy 09-0565
Poa pratensis L. ssp. *pratensis*, 2007 L. Speedy 07-696 Europe
Poa saltuensis Fern. & Wieg. ssp. *saltuensis*, 2008 L. Speedy 08-500
Poa sylvestris A. Gray, 2009 L. Speedy 09-0234
Poa trivialis L., 2008 L. Speedy 08-600 Europe
Schizachyrium scoparium (Michx.) Nash var. *scoparium*, 2008 L. Speedy 08-1046
Setaria faberi Herrm., 2009 L. Speedy 09-803 Asia
Setaria pumila (Poir.) Roemer & J.A. Schultes ssp. *pumila*, 2008 L. Speedy 08-1278 Europe
Setaria viridis (L.) Beauv. var. *viridis*, 1994 W.A. Zanol 3509 Eurasia
Sorghastrum nutans (L.) Nash, 2009 L. Speedy 09-1073
Sorghum halepense (L.) Pers., 1949 J.W. Smith s.n. Mediterranean region
Spartina pectinata Bosc ex Link, 2008 L. Speedy and M. Bowers 08-929-2
Sphenopholis intermedia (Rydb.) Rydb., 1945 O.E. Jennings s.n. [*Sphenopholis obtusata* var. *major*]
Sphenopholis obtusata (Michx.) Scribn., 2009 L. Speedy 09-0558
Sporobolus vaginiflorus (Torr. ex A. Gray) Wood, 1995 F.H. Utech 95-873
Tridens flavus (L.) A.S. Hitchc. var. *flavus*, 1995 F.H. Utech 95-887
Triticum aestivum L., 2008 L. Speedy 08-511 Eurasia
Zea mays L. ssp. *mays*, 1909 D.R. Sumstine s.n. Tropical America

Polemoniaceae

Phlox divaricata L. ssp. *divaricata*, 2008 L. Speedy 08-330
Phlox maculata L. ssp. *maculata*, 1981 F.H. Utech 81-117
Phlox maculata L. ssp. *pyramidalis*, 1953 L.K. Henry and F.H. Beer s.n.
Phlox paniculata L., 2009 L. Speedy 09-634
Phlox stolonifera Sims, 2008 L. Speedy 08-0248
Phlox subulata L. ssp. *subulata*, 1994 B.L. Isaac and J.A. Isaac 6871
Polemonium reptans L. var. *reptans*, 2008 L. Speedy 08-0215

Polygalaceae

Polygala ambigua Nutt., 1951 W.E. Buker and F.H. Beer s.n. [*Polygala verticillata* L. var. *ambigua* (Nutt.) Wood]
Polygala paucifolia Willd., 2009 L. Speedy 09-0205
Polygala sanguinea L., 2009 L. Speedy and M. Lange 09-998
Polygala verticillata L., 2009 L. Speedy and B. Poglein 09-860

Polygonaceae

Fagopyrum esculentum Moench, 1908 O.E. Jennings s.n. Asia
Fallopia cilinodis (Michx.) Holub, 2009 L. Speedy 09-0584 [*Polygonum cilinode* Michx.]
Fallopia convolvulus (L.) A. Löve, 1990 F.H. Utech 90-1270 Eurasia
Fallopia japonica (Houtt.) R. Decr., 2008 L. Speedy 08-1203 Asia
Fallopia sachalinensis (F. Schmidt) R. Decr., 2008 L. Speedy and D. White 08-1243 Asia
Fallopia scandens (L.) Holub, 2007 L. Speedy 07-1793 [*Polygonum scandens* L.]
Persicaria amphibia (L.) S.F. Gray p.p., 2008 L. Speedy 08-1344 [*Polygonum coccineum* Muhl. ex Willd. var. *emersa* (Michx.) Hickman]
Persicaria arifolia (L.) Haralds., 2007 L. Speedy 07-551 [*Polygonum arifolium* L.]
Persicaria hydropiper (L.) Delarbre, 2008 L. Speedy 08-1318 Eurasia
Persicaria hydropiperoides (Michx.) Small, 2008 L. Speedy 08-1345 [*Polygonum hydropiperoides* Michx.]
Persicaria longiseta (Bruijn) Kitagawa, 2008 L. Speedy 08-1264 Asia
Persicaria maculosa S.F. Gray, 1952 L.K. Henry and F.H. Beer s.n. Europe
Persicaria orientalis (L.) Spach, 1968 W. Cuppett s.n. India

Persicaria pensylvanica (L.) M. Gomez, 2008 L. Speedy 08-1127 [*Polygonum pensylvanicum* L.]
Persicaria posumbu (Buch.-Ham. ex D. Don) H. Gross, 2008 L. Speedy 08-430 Asia
Persicaria punctata (Ell.) Small, 2008 L. Speedy 08-1260 [*Polygonum punctatum* Ell.]
Persicaria sagittata (L.) Gross., 2008 L. Speedy 08-1063 [*Polygonum sagittatum* L.]
Persicaria virginiana (L.) Gaertn., 2008 L. Speedy 08-1068 [*Polygonum virginianum* L.]
Polygonum aviculare L. ssp. *aviculare*, 1994 W.A. Zanol 3541 Europe
Polygonum aviculare L. ssp. *depressum*, 1994 W.A. Zanol 3541 Europe
Rumex acetosella L., 1993 W.A. Zanol 1551 Eurasia
Rumex crispus L. ssp. *crispus*, 2009 L. Speedy 09-0436 Europe
Rumex obtusifolius L., 2009 L. Speedy 09-1014 Europe
Rumex verticillatus L., 1952 L.K. Henry and F.H. Beer s.n.

Pontederiaceae
Heteranthera dubia (Jacq.) MacM., 1904 A.E. Ortman s.n. [*Zosterella dubia* (Jacq.) MacM.]

Portulacaceae
Claytonia caroliniana Michx., 2008 L. Speedy 08-0030
Claytonia virginica L. var. *virginica*, 2008 L. Speedy 08-0170
Portulaca oleracea L., 1967 A.G. Shields s.n.

Potamogetonaceae
Potamogeton crispus L., 2007 L. Speedy, C. Tracey and E. Trexler 07-966 Europe
Potamogeton diversifolius Raf., 2008 L. Speedy and M. Bowers 08-923
Potamogeton epihydrus Raf., 2009 L. Speedy 09-918
Potamogeton foliosus Raf. ssp. *foliosus*, 2009 L. Speedy 09-922
Potamogeton nodosus Poir., 2007 L. Speedy, C. Tracey and S. Stewart 07-987
Potamogeton spirillus Tuckerman, 1984 M. Polechko s.n.
Stuckenia pectinata (L.) Böerner, 2008 L. Speedy, J.A. Isaac, B.L. Isaac and BSWP 08-1023

Primulaceae
Lysimachia ciliata L., 2009 L. Speedy 09-0569
Lysimachia nummularia L., 1965 A.G. Shields s.n. Europe
Lysimachia quadrifolia L., 2008 L. Speedy 08-571
Lysimachia terrestris (L.) B.S.P., 1968 A.G. Shields s.n.
Lysimachia vulgaris L., 2008 L. Speedy and M. Bowers 08-931 Eurasia
Trientalis borealis Raf. ssp. *borealis*, 2007 L. Speedy LS-07-305

Pyrolaceae
Chimaphila maculata (L.) Pursh, 2009 L. Speedy and C. Rogers 09-590
Pyrola americana Sweet, 1971 W.E. Buker s.n.
Pyrola elliptica Nutt., 1994 B.L. Isaac and J.A. Isaac 6886

Ranunculaceae
Actaea pachypoda Ell., 2008 L. Speedy 08-0292 [*Actaea alba* auct. non (L.) P. Mill.]
Actaea podocarpa DC., 2008 L. Speedy 08-1266 **G4:S3** [*Cimicifuga americana* Michx.]
Actaea racemosa L., 2008 L. Speedy 08-1322 [*Cimicifuga racemosa* (L.) Nutt.]
Anemone canadensis L., 1945 O.E. Jennings s.n.
Anemone quinquefolia L. var. *quinquefolia*, 2008 L. Speedy 08-331
Anemone virginiana L. var. *virginiana*, 2008 L. Speedy 08-724
Aquilegia canadensis L., 2008 L. Speedy 08-0188
Caltha palustris L. var. *palustris*, 2007 L. Speedy and C. Tracey LS-07-337
Clematis virginiana L., 2008 L. Speedy 08-886
Coptis trifolia (L.) Salisb., 1969 J. Rummel s.n.
Ficaria verna Huds., 2008 L. Speedy 08-0146 Eurasia
Hepatica nobilis Schreber var. *acuta*, 2008 L. Speedy 08-0052 [*Anemone acutiloba* (DC.) G. Lawson]
Hepatica nobilis Schreber var. *obtusa*, 2008 L. Speedy 08-950 [*Hepatica americana* (DC.) Ker-Gawl.]
Hydrastis canadensis L., 2009 L. Speedy 09-0160 **G4:S4**
Ranunculus abortivus L., 2009 L. Speedy 09-0209
Ranunculus acris L. var. *acris*, 2008 L. Speedy 08-595 Europe
Ranunculus allegheniensis Britt., 1952 L.K. Henry and F.H. Beer s.n.
Ranunculus bulbosus L., 1946 M.S. Lewis s.n. Europe
Ranunculus hispidus Michx. var. *caricetorum*, 2007 L. Speedy LS-07-295 [*Ranunculus caricetorum* Greene]
Ranunculus hispidus Michx. var. *hispidus*, 2009 L. Speedy 09-0208
Ranunculus hispidus Michx. var. *nitidus*, 2009 L. Speedy 09-0214 [*Ranunculus septentrionalis* Poir.]
Ranunculus recurvatus Poir., 2009 L. Speedy 09-0210
Ranunculus repens L., 2009 L. Speedy 09-667 Europe
Thalictrum coriaceum (Britt.) Small, 2008 L. Speedy 08-418-2 **G4:S2**
Thalictrum dioicum L., 2008 L. Speedy 08-0125
Thalictrum pubescens Pursh, 2009 L. Speedy 09-0559
Thalictrum thalictroides (L.) Eames & Boivin, 2009 L. Speedy 09-0150

Rhamnaceae
Ceanothus americanus L., 2008 L. Speedy 08-687

Rosaceae
Agrimonia gryposepala Wallr., 2009 L. Speedy 09-1006
Agrimonia parviflora Ait., 2009 L. Speedy 09-898
Agrimonia pubescens Wallr., 2007 L. Speedy 07-889
Agrimonia striata Michx., 2009 L. Speedy 09-811
Amelanchier arborea (Michx. f.) Fern., 2009 L. Speedy 09-1093
Amelanchier laevis Wieg., 2009 L. Speedy 09-0451
Amelanchier spicata (Lam.) K. Koch, 2009 L. Speedy 09-0219 [*Amelanchier stolonifera* Wieg.]
Aruncus dioicus (Walt.) Fern., 1957 M.S. Lewis s.n.
Crataegus chrysocarpa Ashe var. *chrysocarpa*, 2009 L. Speedy 09-0195 [*Crataegus coccinea* L. p.p.]
Crataegus crus-galli L., 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-827
Crataegus intricata Lange, 2009 L. Speedy 09-0159-1
Crataegus macrosperma Ashe, 2008 L. Speedy 08-1185
Crataegus pruinosa (Wendl. f.) K. Koch, 2008 L. Speedy 08-0183-2
Crataegus punctata Jacq., 2009 L. Speedy 09-676
Crataegus schuettei Ashe, 2009 L. Speedy 09-0564
Filipendula rubra (Hill) B.L. Robins., 2009 L. Speedy 09-632-2 **G4G5:S1S2**
Fragaria vesca L. ssp. *vesca*, 2008 L. Speedy 08-0266
Fragaria virginiana Duchesne ssp. *virginiana*, 2008 L. Speedy 08-0148
Geum canadense Jacq. var. *canadense*, 2008 L. Speedy 08-594
Geum laciniatum Murr. var. *trichocarpum*, 2009 L. Speedy 09-0577
Gillenia trifoliata (L.) Moench, 2008 L. Speedy 08-682 [*Porteranthus trifoliatus* (L.) Britt.]
Malus coronaria (L.) P. Mill., 2007 L. Speedy 07-790-1 [*Malus glaucescens* Rehd.]
Malus pumila P. Mill., 2008 L. Speedy 08-0141 Eurasia
Photinia melanocarpa (Michx.) Robertson & Phipps, 2008 L. Speedy 08-1210 [*Aronia melanocarpa* (Michx.) Ell.]
Physocarpus opulifolius (L.) Maxim. var. *opulifolius*, 2008 L. Speedy 08-389B
Potentilla canadensis L. var. *canadensis*, 2008 L. Speedy 08-0178
Potentilla norvegica L. ssp. *monspeliensis*, 2008 L. Speedy 08-1074
Potentilla recta L., 1946 H. Roslund s.n. Europe
Potentilla simplex Michx., 2009 L. Speedy 09-0235
Prunus americana Marsh., 1952 L.K. Henry and F.H. Beer s.n.
Prunus avium (L.) L., 2007 L. Speedy and C. Tracey LS-07-339 Eurasia

Prunus mahaleb L., 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-829 Europe
Prunus pensylvanica L. f. var. *pensylvanica*, 2008 L. Speedy 08-0150
Prunus serotina Ehrh. var. *serotina*, 2008 L. Speedy 08-388C
Prunus virginiana L., 2008 L. Speedy 08-706
Rosa carolina L. var. *carolina*, 2007 L. Speedy, C. Tracey, S. Stewart, T. Vechter and E. Trexler 07-802
Rosa multiflora Thunb. ex Murr., 2008 L. Speedy 08-662 Asia
Rosa palustris Marsh., 1968 J. A. Ahlborn s.n.
Rosa rubiginosa L., 1957 M.S. Lewis s.n. Europe
Rubus allegheniensis Porter var. *allegheniensis*, 2009 L. Speedy 09-0244-2
Rubus dalibarda L., 1908 O.E. Jennings s.n.
Rubus flagellaris Willd., 2009 L. Speedy 09-0242 [*Rubus enslenii* Tratt.]
Rubus hispidus L., 2009 L. Speedy 09-668
Rubus occidentalis L., 2008 L. Speedy 08-389G
Rubus odoratus L. var. *odoratus*, 2008 L. Speedy 08-979
Rubus pensilvanicus Poir., 2008 L. Speedy 08-389F
Rubus plicatifolius Blanch., 1908 O.E. Jennings s.n.
Rubus pubescens Raf. var. *pubescens*, 2007 L. Speedy 07-1116
Sorbus americana Marsh., 1968 D. Bowman s.n.
Spiraea alba Du Roi var. *alba*, 2009 L. Speedy 09-662
Spiraea japonica L. f. var. *fortunei*, 2009 L. Speedy 09-674 Japan
Spiraea tomentosa L., 2008 L. Speedy and M. Bowers 08-918
Waldsteinia fragarioides (Michx.) Tratt. ssp. *fragarioides*, 2009 L. Speedy 09-0211

Rubiaceae
Cephalanthus occidentalis L., 2008 L. Speedy and M. Bowers 08-924
Galium aparine L., 2008 L. Speedy 08-332
Galium asprellum Michx., 2009 L. Speedy 09-897
Galium circaezans Michx., 2008 L. Speedy 08-1058
Galium concinnum Torr. & A. Gray, 1945 O.E. Jennings s.n.
Galium lanceolatum Torr., 1952 L.K. Henry and F.H. Beer s.n.
Galium mollugo L., 1969 A.G. Shields s.n. Eurasia
Galium tinctorium (L.) Scop., 2007 L. Speedy and C. Tracey 07-981
Galium triflorum Michx., 2008 L. Speedy 08-955
Galium verum L. var. *verum*, 1935 W.R. VanDersal s.n. Eurasia
Houstonia caerulea L., 2007 L. Speedy LS-07-433
Mitchella repens L., 2009 L. Speedy 09-0441

Salicaceae
Populus grandidentata Michx., 2008 L. Speedy 08-0093
Populus tremuloides Michx., 1952 L.K. Henry and F.H. Beer s.n.
Salix discolor Muhl., 2007 L. Speedy and C. Tracey LS-07-340
Salix eriocephala Michx., 1942 O.E. Jennings s.n.
Salix humilis Marsh. var. *humilis*, 1956 L.K. Henry and W.E. Buker s.n.
Salix nigra Marsh., 2008 L. Speedy and M. Bowers 08-927
Salix petiolaris Sm., 2007 L. Speedy and C. Tracey 07-1502 **G5:S4** [*Salix × subsericea* (Anderss.) Schneid.]
Salix sericea Marsh., 2009 L. Speedy 09-0194-2

Saxifragaceae
Chrysosplenium americanum Schwein. ex Hook., 2008 L. Speedy 08-0203
Heuchera americana L. var. *americana*, 2008 L. Speedy 08-683
Micranthes pensylvanica (L.) Haw., 1908 O.E. Jennings s.n.
Micranthes virginiensis (Michx.) Small, 2008 L. Speedy 08-337
Mitella diphylla L., 2009 L. Speedy 09-0224
Tiarella cordifolia L., 2008 L. Speedy 08-346

Scrophulariaceae
Aureolaria laevigata (Raf.) Raf., 2007 L. Speedy 07-1111
Aureolaria pedicularia (L.) Raf., 1901 J.A. Shafer s.n.
Aureolaria virginica (L.) Pennell, 2008 L. Speedy 08-816
Chaenorhinum minus (L.) Lange, 2008 L. Speedy 08-510 Europe
Chelone glabra L., 2008 L. Speedy 08-1168
Gratiola neglecta Torr., 2009 L. Speedy 09-624
Linaria vulgaris P. Mill., 1990 F.H. Utech 90-1231 Eurasia
Lindernia dubia (L.) Pennell var. *dubia*, 2008 L. Speedy 08-902
Melampyrum lineare Desr. var. *lineare*, 1908 O.E. Jennings s.n. [*Melampyrum lineare* var. *americanum* (Michx.) Beauverd]
Mimulus alatus Ait., 2007 L. Speedy and C. Tracey 07-1496
Mimulus ringens L. var. *ringens*, 2008 L. Speedy 08-1144
Pedicularis canadensis L. ssp. *canadensis*, 2009 L. Speedy 09-815
Penstemon digitalis Nutt. ex Sims, 2009 L. Speedy 09-611
Penstemon laevigatus Ait., 1945 O.E. Jennings s.n. **G5:S3**
Scrophularia lanceolata Pursh, 2008 L. Speedy 08-438
Scrophularia marilandica L., 2009 L. Speedy 09-791
Verbascum blattaria L., 1982 M. Cipollini s.n. Eurasia
Verbascum thapsus L., 1954 M.S. Lewis s.n. Europe
Veronica americana Schwein. ex Benth., 1948 E. Mason s.n.
Veronica anagallis-aquatica L., 1964 A.G. Shields s.n.
Veronica arvensis L., 1946 L.K. Henry s.n. Eurasia
Veronica officinalis L., 2009 L. Speedy 09-0246
Veronica serpyllifolia L. ssp. *serpyllifolia*, 1972 L.K. Henry and W.E. Buker s.n. Europe
Veronicastrum virginicum (L.) Farw., 2008 L. Speedy 08-879

Simaroubaceae
Ailanthus altissima (P. Mill.) Swingle, 2009 L. Speedy 09-1071 Asia

Smilacaceae
Smilax glauca Walt., 1901 J.A. Shafer s.n.
Smilax herbacea L., 1987 F.H. Utech 87-086
Smilax rotundifolia L., 2008 L. Speedy 08-962

Solanaceae
Physalis heterophylla Nees var. *heterophylla*, 2008 L. Speedy 08-803
Physalis longifolia Nutt. var. *subglabrata*, 1990 F.H. Utech 90-1253 [*Physalis subglabrata* Mackenzie & Bush]
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NYMPHOIDES HUMBOLDTIANA (MENYANTHACEAE) IN UVALDE COUNTY, TEXAS—A NEW RECORD FOR THE U.S.A.

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ABSTRACT

Nymphoides (Menyanthaceae) plants from the Nueces River, Uvalde County, Texas, previously identified as *N. indica* (L.) Kuntze, are determined genetically to be identical to *N. humboldtiana* (Kunth) Kuntze specimens. This report documents the first record of the species not only in Texas but also in the United States.

RESUMEN

Plantas de *Nymphoides* (Menyanthaceae) recolectadas en Rio Nueces (Condado de Uvalde, Texas) previamente descritas como *N. indica* (L.) Kuntze, han sido identificadas genéticamente como idénticas a especímenes de *N. humboldtiana* (Kunth) Kuntze. En este articulo se documenta el primer registro de la especie no solo en Texas, sino tambien en los Estados Unidos de America.

Saunders (2005) previously reported the existence of an isolated population of *Nymphoides* from Uvalde County, Texas, which he identified as *N. indica* (L.) Kuntze following the broad species concept proposed by Ornduff (1969). Although Ornduff (1969) recommended the synonymy of the Old World tropical species *N. indica* and the morphologically similar New World *N. humboldtiana* (Kunth) Kuntze, a recent phylogenetic study by Tippery and Les (2011) argued that these taxa should be maintained as separate species.

The morphological similarity that other authors have noted between *N. humboldtiana* and *N. indica* reflects in part the spectrum of variation found within Old World *N. indica*. This species comprises plants from a wide geographical range that vary in diagnostic characters such as petal ornamentation and seed morphology (Tippery & Les 2011). Various *Nymphoides* species are grown in cultivation, and the specimens identified as *N. indica* by Saunders (2005) may have originated as escapes. Alternatively, the Texas specimens may represent the northern range extent of *N. humboldtiana*, a species that occurs naturally in México.

In order to confirm the identification of *N. indica* in Texas, we collected and analyzed material from the locality described by Saunders (2005). We extracted and sequenced genomic DNA for one nuclear (ITS) and one chloroplast (*matK/trnK*) region, following the methods reported by Tippery and Les (2011). Newly obtained DNA sequences were deposited in GenBank under the accession numbers JF930150 (ITS) and JF930151 (*matK/trnK*). As a result of this approach, we ascertained that the Texas plants did not match *N. indica* but instead were identical genetically to *N. humboldtiana* specimens at diagnostic sites in both nuclear and chloroplast gene regions (Tippery & Les 2011).

Consequently, the appropriate species name for the *Nymphoides* growing in Uvalde County is *N. humboldtiana*. This species occurs naturally in North and South America, from Uruguay north to southern Tamaulipas, México (Tropicos.org 2011), and it is quite reasonable to expect that it could persist in southern Texas also. The broad geographical range of *N. humboldtiana* was illustrated by Tippery and Les (2011), who determined that plants from Brazil, Ecuador, and México all were genetically attributable to this species. Prior to our study, however, the northernmost known population of *N. humboldtiana* was approximately 750 km south of the population reported here (Tropicos.org 2011). As a result of this study, we have identified the Nueces River plants as the only known instance of *N. humboldtiana* in the United States and also the northernmost locality for the species.

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Voucher specimens: **U.S.A. TEXAS. Uvalde Co.:** Uvalde, Nueces River, c. 200 m N of where CR-202 crosses river, in pond E of main watercourse, in gently-flowing water of spring, 0.2–1.0 m deep, 29°11'08.9"N, 99°53'44.5"W, 13 Jul 2010, *Tippery 331 & Les 854* (CONN); Nueces River, in shaded side channel on eastern bank of river off of Highway 90, 5.68 mi W of Uvalde, left on county road which dead ends at river, 29°10'53.44"N, 99°53'44.80"W, 13 Jul 2010, *Williams 44* (SWT).

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The 23rd Annual Delzie Demaree Travel Award was presented at the 57th Annual Systematics Symposium (7–8 Oct. 2011) at the Missouri Botanical Garden, St. Louis. Two students were presented the Travel Award: **Aleksandar Radosavlievic**, Chicago Botanic Garden and Northwestern University and **Christin Fotis,** Southern Illinois, University Carbondale.

The 2011 Travel Awards were underwritten by **1)** Delzie Demaree Travel Award Endowment, and **2)** Members of the Delzie Demaree Travel Award Committee.

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The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

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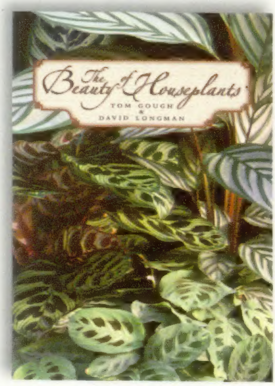
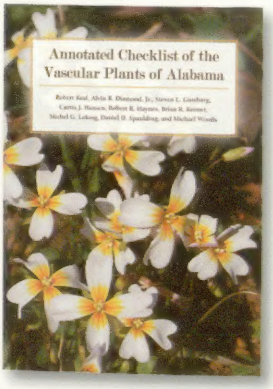
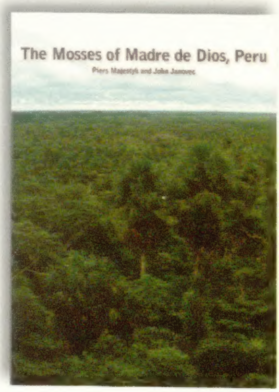


The Beauty of Houseplants is set apart from the normal houseplant care book by being a total delight to look at. The illustrations of over 70 houseplants are in themselves artistic and stunning, capturing the extraordinary variety and beauty of temperate plants with a detailed guide to their individual care and how to put right what goes wrong. The susceptibility of each plant to pests and diseases is dealt with separately and in detail with a chapter on their identification and how to deal with them. There is a section showing how to choose plants for each room of the house, depending on the amounts of heat, light and humidity. A potted history of how houseplants were discovered from all over the world and a chapter on propagation make this one of the most delightful reference books ever created on the subject.



The Annotated Checklist of the Vascular Plants of Alabama presents the first comprehensive statewide checklist of vascular plants for Alabama in over 100 years. Despite numerous county-level and regional plant checklists, Alabama has lacked a comprehensive and modern checklist or flora of since Charles Mohr's 1901 publication of Plant Life of Alabama. This compilation is based on thousands of voucher collections made primarily by the authors over decades of field work in the state. The combined total of 3,743 species and 1,120 genera in 204 families indicates considerable floristic variety and elevates Alabama high among states with great overall plant diversity. As plant research and discovery in Alabama continues forward, this list will serve as a baseline for understanding the diversity of plant life in the state and will prove useful to botanists, conservation biologists, ecologists and anyone interested in or working on vascular plants in Alabama.



In this field manual the authors present a guide to the mosses currently known from eastern Madre de Dios, Peru, with focus on the Los Amigos River watershed and specifically, the Los Amigos Biological Station and Conservation Concession. *The Mosses of Madre de Dios, Peru* treats some 63 species in 40 genera and 28 families. Keys, detailed descriptions, ecological information, and illustrations (61 b/w line drawings, 6 color plates) are provided. A glossary, reference section, and index are included.

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